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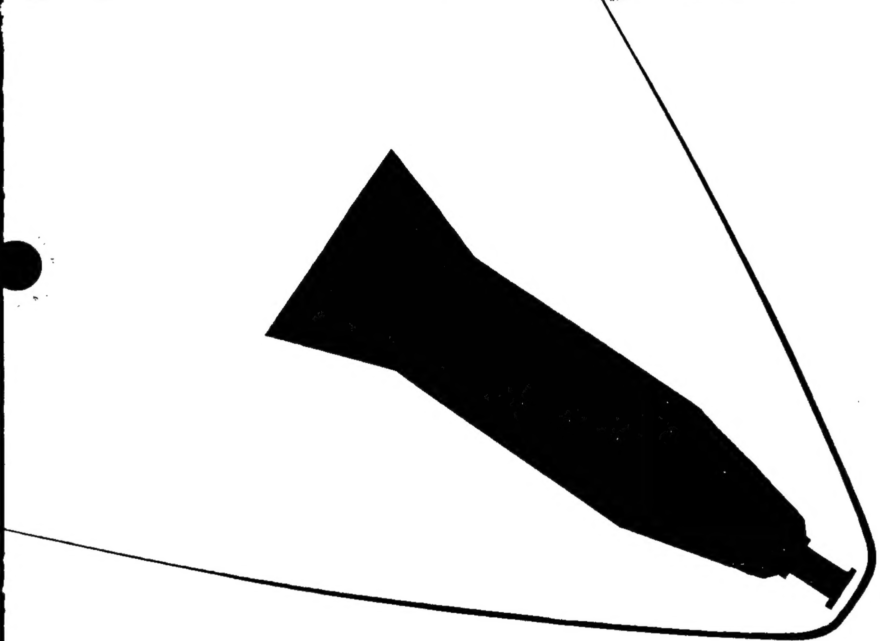

AEROSPACE NUCLEAR SAFETY

ROVER/NERVA DESTRUCT SYSTEM TEST RESULTS
ABERDEEN PROVING GROUND - 3
(Final Report)

SANDIA CORPORATION

PRIME CONTRACTOR TO THE
UNITED STATES ATOMIC
ENERGY COMMISSION
ALBUQUERQUE, NEW MEXICO
LIVERMORE, CALIFORNIA

SC-RR-65-620

ROVER/NERVA DESTRUCT SYSTEM TEST RESULTS ABERDEEN PROVING GROUND - 3 (Final Report)

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December 1965

ABSTRACT

The ROVER/NERVA Nuclear Propulsion Engine destruct test was performed to determine the distribution, particle size and mass, and particle velocity of the debris. These debris data are the input data for a computer analysis of the safety aspects of using the NERVA reactor for space flight.

Reported in this document are the debris distribution, size, mass, and velocity measured during the destruct test. These data are presented as tables and as graphs.

ACKNOWLEDGMENT

The authors wish to express their appreciation for the contributions of A. Juskiewicz, 3311 and D. R. Parker, 3311 who reported air sampling data; J. Karo, 7226 who provided the photographic coverage; H. J. Plagge, 7325 who reported the firing sequence; R. D. Jones, 7332 who measured the pressures and case breakup; and B. S. Hill, 9312 and H. J. Gay, 9312 who reported the velocity data acquired from the rotating foam velocity devices.

The authors also wish to express their appreciation to all Sandia personnel not specifically mentioned for their help and assistance in the performance of the full-scale test.

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a prime contractor to the
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SUMMARY

In partial fulfillment of its responsibility to the AEC for the safety analyses of nuclear power supplies to be used in space, Sandia Corporation has performed a full-scale destruct test of the ROVER/NERVA space propulsion engine. In the test, a full-scale mock up of the ROVER/NERVA was destroyed by four statically emplaced, 105 mm special explosive charges.

The information and data obtained from the test, requested by the joint AEC/NASA Space Nuclear Propulsion Office, were to establish the spatial distribution of particles, the size distribution as a function of the mass, and velocity. The instrumentation for the full-scale destruct test successfully obtained the desired data. Particle sizes up to 20 microns were obtained by air sampling, but these small particles did not contain uranium. Pressure measurements obtained were 23 psi at 20 feet, 8 psi at 30 feet and 4.2 psi at 40 feet. Graphite debris velocity recorded was 570 fps over 20 feet; however, the debris velocity dropped to 420 fps over 70 feet.

Part of the debris from this test was distributed radially, and the remainder was dispersed in five concentrated jets. The metallic components (skin, reflectors, and control drums) were deployed in a symmetrical radial pattern, and each numbered component moved on a radial line from its location prior to the destruct test. The core and graphite reflector did not follow the radial pattern but flowed within the core cavity and were deployed in four horizontal jets, 90 degrees apart, and in a vertical jet.

Approximate velocities observed at 100 milliseconds after detonation were:

Skin	400 fps
Horizontal Jets	400 fps
Vertical Jet	600 fps

The control drums were not observed until about 400 milliseconds after detonation; at this time, the velocity was about 100 fps.

The graphite core was reduced to a median size of 0.12 inch or 3.0 mm diameter. Within the core material collected, essentially no uranium was detected below 53 microns.

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Introduction

An acceptable evaluation of the safety criteria must be completed before any nuclear material can be used in an aerospace mission. The safety analysis depends on the method of destruction proposed for the vehicle carrying the nuclear material.

For the ROVER/NERVA propulsion engine, a suitable nonnuclear explosive destruct system has been developed by Aberdeen Proving Ground and Picatinny Arsenal for the postoperational destruct of the reactor, but the character of the resulting debris has not been fully defined. The characterization of debris is the source term for a computer analysis of the safety criteria from which the resulting dispersion, fallout, and the ultimate safety criteria can be established.

To acquire this input information, which includes three dimensional debris distribution, debris size and mass, and debris velocity, a full-scale mockup of the ROVER/NERVA nuclear propulsion engine was destroyed by four statically emplaced 105 mm special explosive charges.

Purpose of Test

The joint AEC/NASA Space Nuclear Propulsion Office (SNPO) requested the following specific data from the explosive destruct of a mockup nuclear propulsion engine:

1. Dynamics of Destruct Event
   a. Velocity of fragments of core, reflector, and pressure vessel as a function of fragment size and time.
   b. Angular distribution of fragments of core, reflector, and pressure vessel as functions of fragment size and time.
   c. Reconstruction of geometry of debris pattern of test as function of time on triaxial coordinate system.
   d. Extrapolation of geometry of "c" above to vacuum destruct condition on triaxial coordinate system.
2. Particle Size Distribution
   a. Qualitative determination of particle size distribution of fuel fragments in sufficient detail to construct distribution curve with good level of confidence.
   b. Fuel samples in metric system at points 30, 20, 10, 5, and 1 mm; 750, 500, 250, 100, 50, 10, and 1 microns.

c. Fuel classification as to angularity, sphericity, 1/d, surface area, and density (fragment characterization).

d. Qualitative determination of fragment size distribution of other engine components.

3. Mass Density Distribution of Debris

4. Two Dimensional Mapping of Debris

5. Weight and Size of Components Recovered

These data requirements, combining the collection of fundamental data with the analyses of the fundamental data, establish the entire postoperational destruct pattern.

Requirements 1a, 1b, and 2a above are considered fundamental data and were collected as described later in this report. Requirements 2a, 2b, 2c, 3, 4, and 5 above were fulfilled either by the analyses of data collected as fundamental data or by the examination of the destruct site and the collection of debris from the destruct site.

All of the above items are discussed in this report with the exception of 1c and 1d.

To provide confidence that these data requirements could be met on a full-scale destruct test, a series of 25 development tests were performed prior to the actual full-scale test. These development tests were performed in two main phases; that is, the first 12 tests were performed using a solid graphite block and a single centrally located charge, and the second 12 tests were performed using scale-model ROVER/NERVA test vessels and four explosive charges. These development tests served as a basis for the full-scale test planning and gave a high level of confidence that the required data would be acquired from the full-scale destruct test.

Test Participation

The full-scale destruct systems test was requested by the joint AEC/NASA Space Nuclear Propulsion Office and was scheduled for completion at Aberdeen Proving Ground under the direction of Mortar and Recoilless Rifles Branch of the Artillery Division of Development and Proof Services (D&PS).

At a later date SNPO requested through the AEC, Director of Reactor Development Office, that Sandia Corporation (SC) develop instrumentation to assist in collecting the needed data on the debris after the explosive destruction of the propulsion engine.

The Artillery Branch of Development and Proof Services and the Aerospace Nuclear Safety Department (SC) prepared a joint test plan for instrumentation of the full-scale destruct test (Appendix A), developed the required instrumentation, and, on June 22, 1965, at 1:53 PM local time, performed the destruct systems test of the ROVER/NERVA propulsion engine mockup.

Test Site

The Aberdeen Proving Ground test site, the "Old Bombing Field," was cleared, filled, and graded to a radius of 600 feet around ground zero. Within this graded area, Sandia was assigned the south and west quadrants and Aberdeen Proving Ground the north and east quadrants. Figures 1 and 2 are helicopter views of the test site with the important features labeled. Figure 1 gives a view of the entire test area and labels those features which are prominent enough to allow identification. Figure 2 is a closer view of the test site with labeling on the close-in features and some duplicate labeling to allow orientation between Figures 1 and 2. Figure 3 shows the locations for all Sandia Corporation instrumentation.

Radiation Safety Measures

The core of the mockup ROVER/NERVA propulsion engine was fabricated from depleted uranium to simulate the actual core material. Although this material has a very low radiation hazard, proper safety procedures precluded any detrimental effect to the personnel involved in the test preparation or in data collection after the test.

Included in the Appendix are copies of the Aberdeen Proving Ground's procedures used during the operation.

Description of Instrumentation

The full-scale destruct test was instrumented with equipment and techniques developed during scale-model testing performed before the full-scale test. The instrumentation hardware and physical layout are described in this section of the report.

A. Air Sampling

The purpose of the air sampling program was to collect atmospheric samples in the vicinity of ground zero after the NERVA reactor had been destroyed with 111.17 pounds of DATB explosive. From these samples, the concentration of graphite dust particles in the resulting cloud and the shape and size distribution of the particles that remained airborne were to be determined.

The atmospheric samples were collected by means of midget impingers (Figure 4) suspended from overhead cables. The cables were held about 80 feet above and around ground zero. Three midget impingers were secured to each of eight drop lines from the overhead cables and were located at 30, 50, and 70 feet above the ground. Each line of impingers was 100 feet from ground zero, and the resulting array of 24 samplers formed a cylinder 200 feet in diameter and 70 feet high. This array of samplers allowed 360-degree coverage and would provide a representative sample in a light and variable wind (Figure 5).

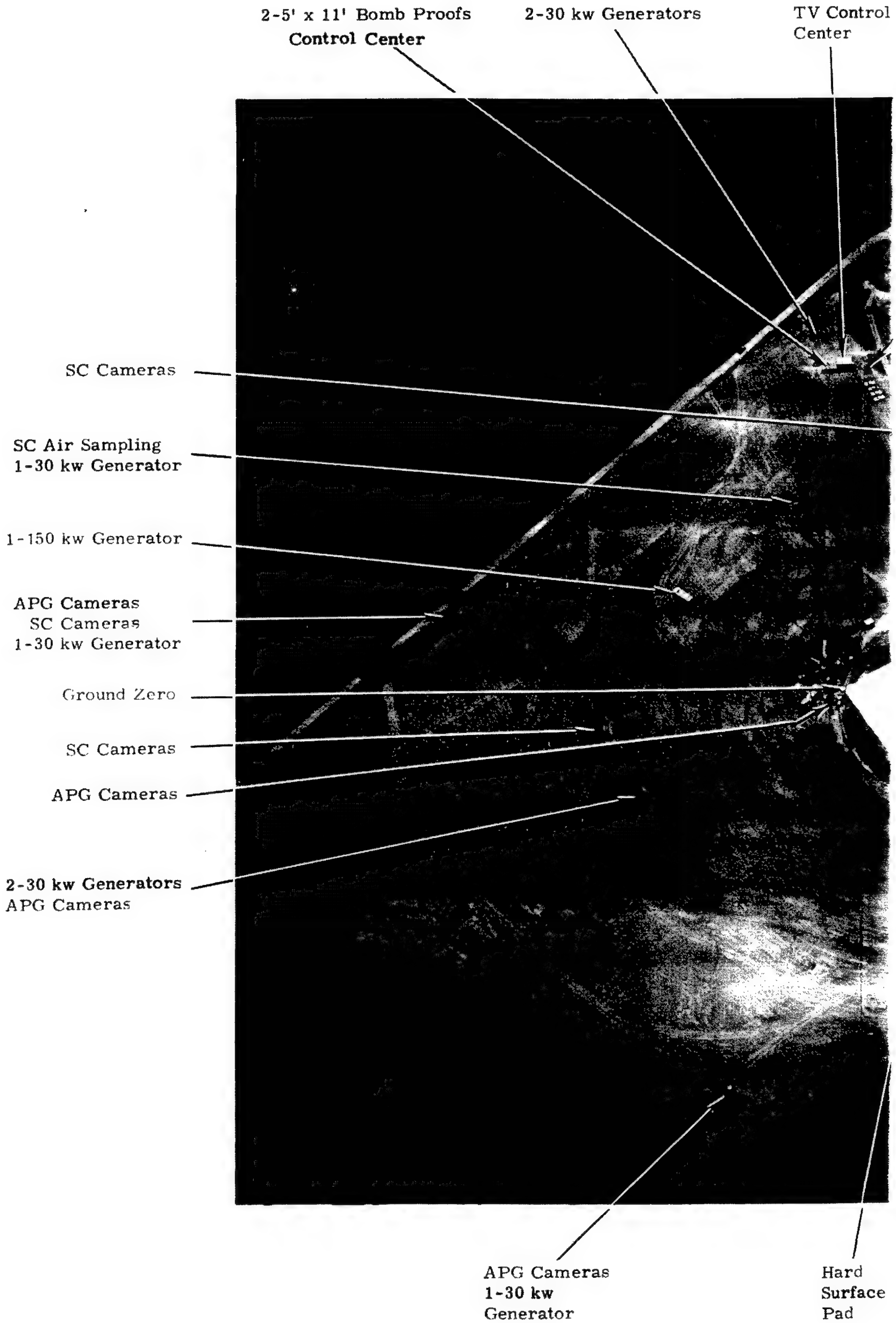
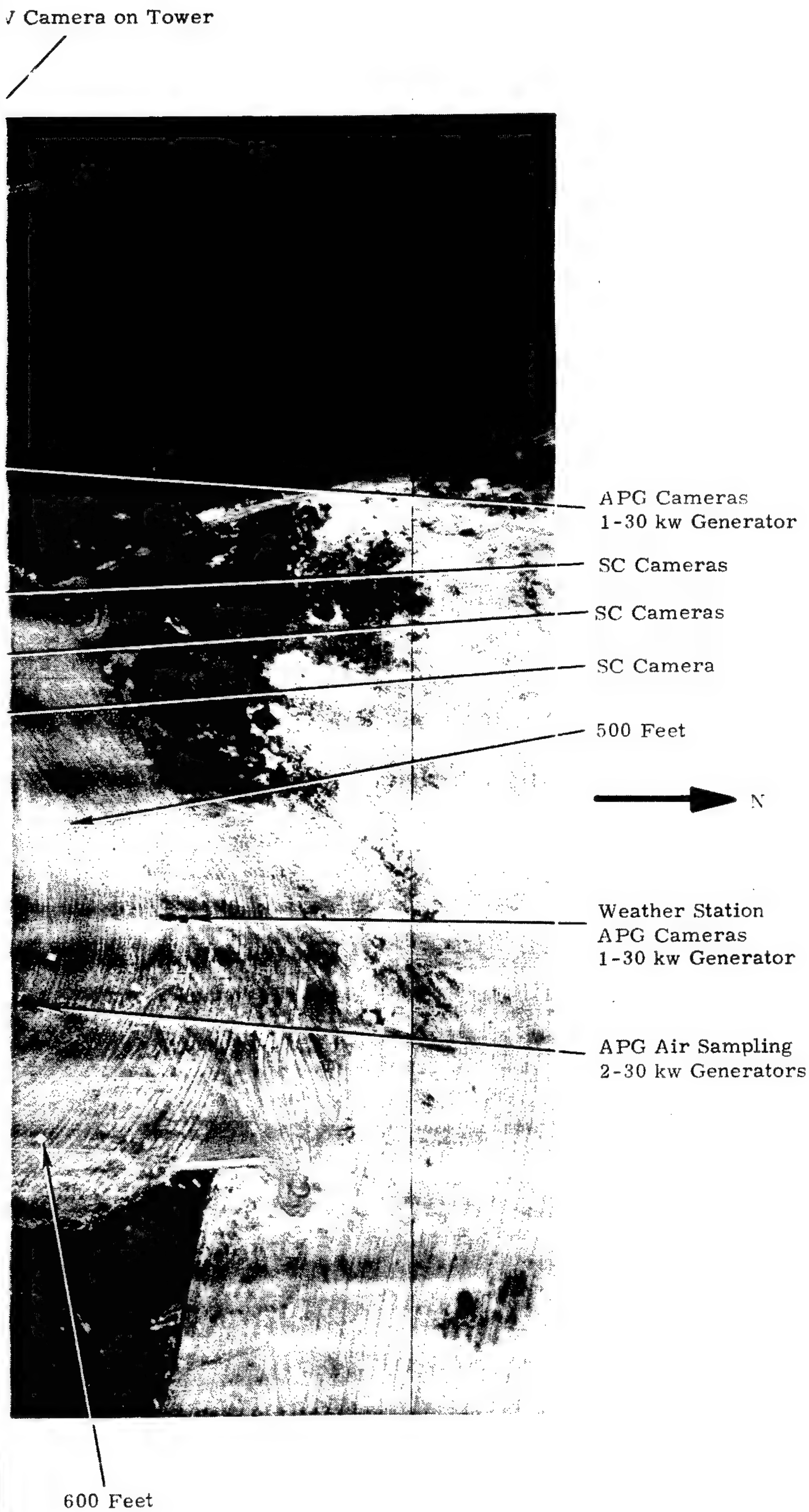

2-5' x 11' Bomb Proofs
Control Center
2-30 kw Generators
TV Control
Center
SC Cameras
SC Air Sampling
1-30 kw Generator
1-150 kw Generator
APG Cameras
SC Cameras
1-30 kw Generator
Ground Zero
SC Cameras
APG Cameras
2-30 kw Generators
APG Cameras
APG Cameras
1-30 kw
Generator
Hard
Surface
Pad

Figure 1.

Figure 1. Test Site


√ Camera on Tower
APG Cameras
1-30 kw Generator
SC Cameras
SC Cameras
SC Camera
500 Feet
N
Weather Station
APG Cameras
1-30 kw Generator
APG Air Sampling
2-30 kw Generators
600 Feet

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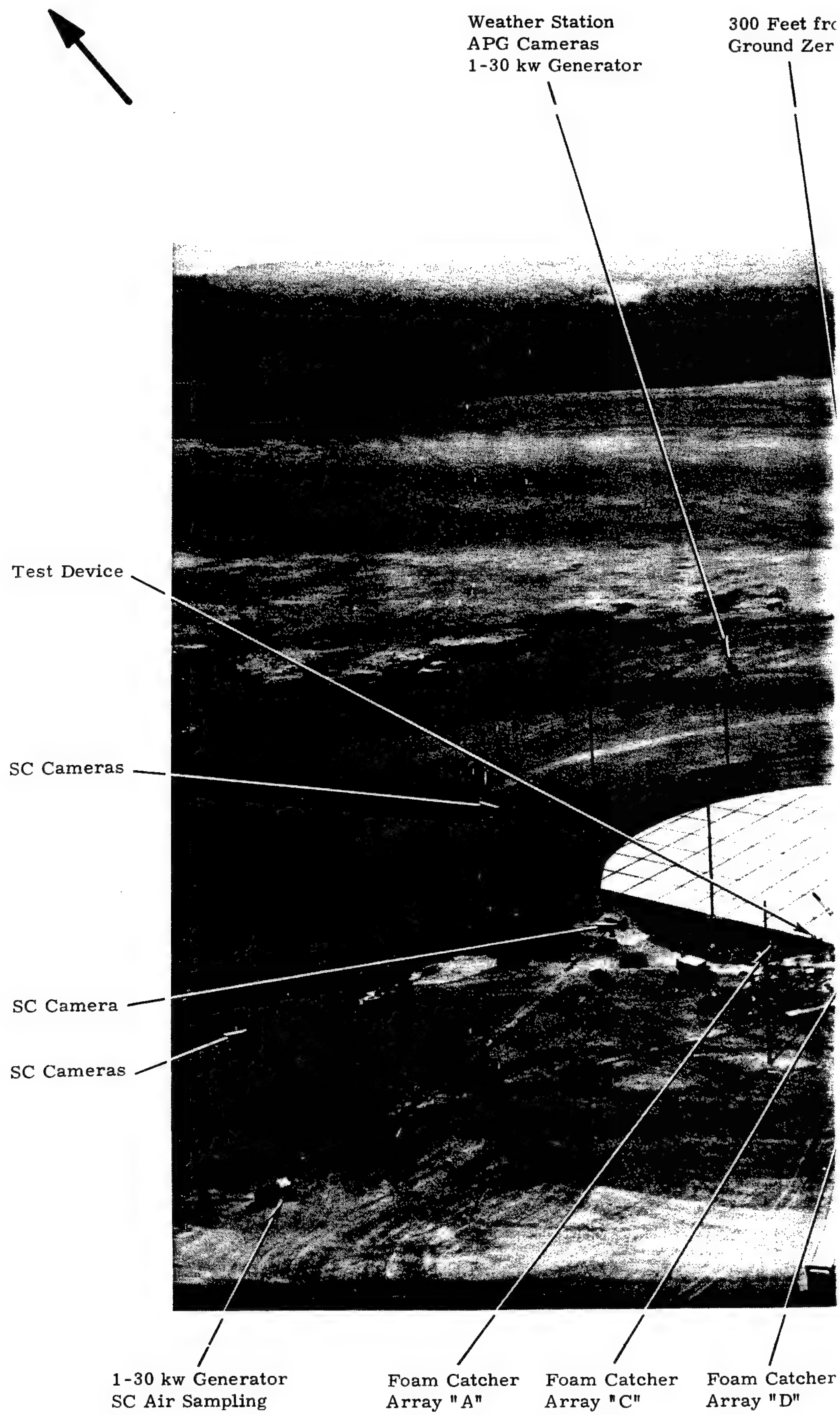


Weather Station
APG Cameras
1-30 kw Generator
300 Feet fr
Ground Zer
Test Device
SC Cameras
SC Camera
SC Cameras
1-30 kw Generator
SC Air Sampling
Foam Catcher
Array "A"
Foam Catcher
Array "C"
Foam Catcher
Array "D"

Figu

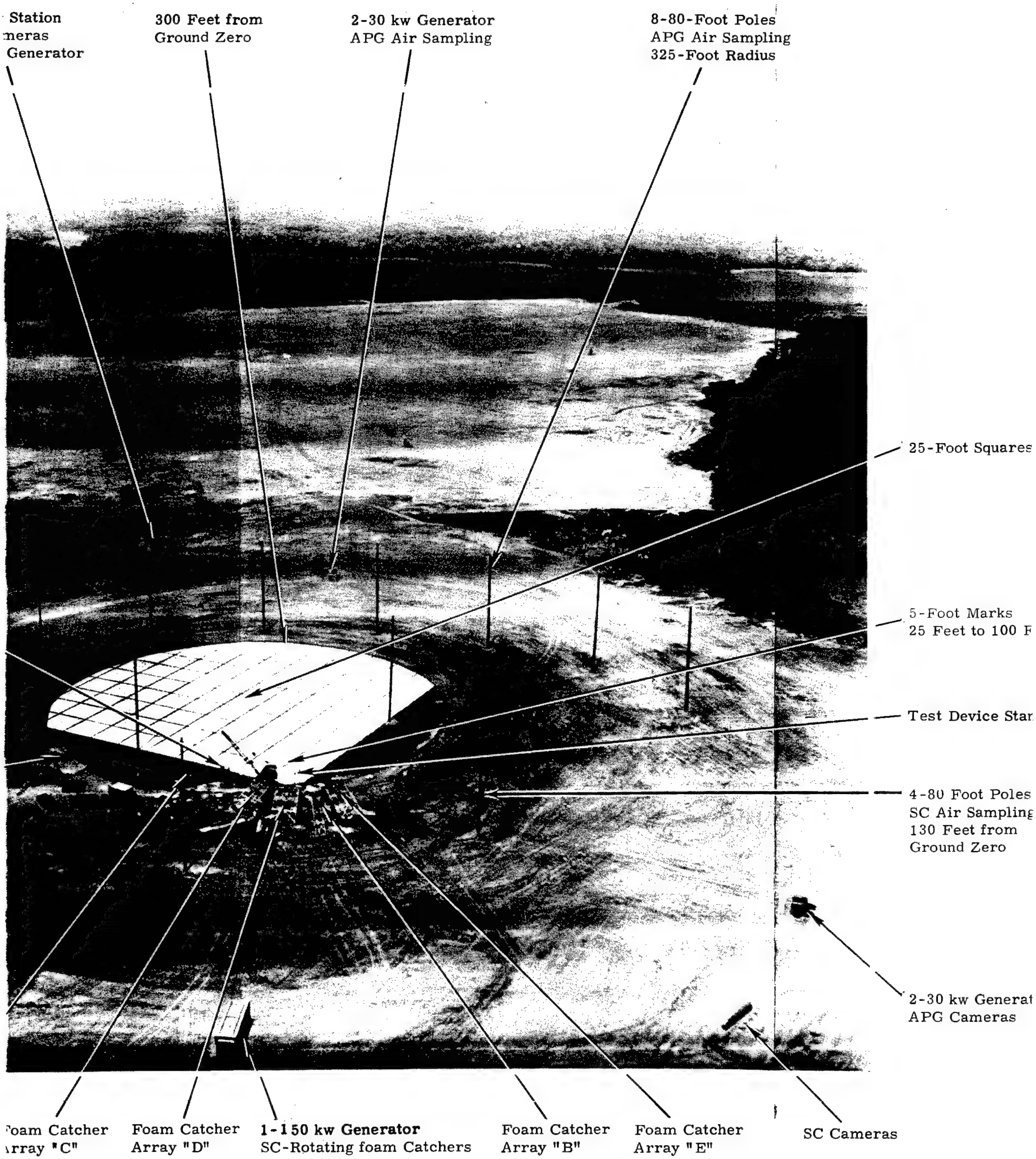
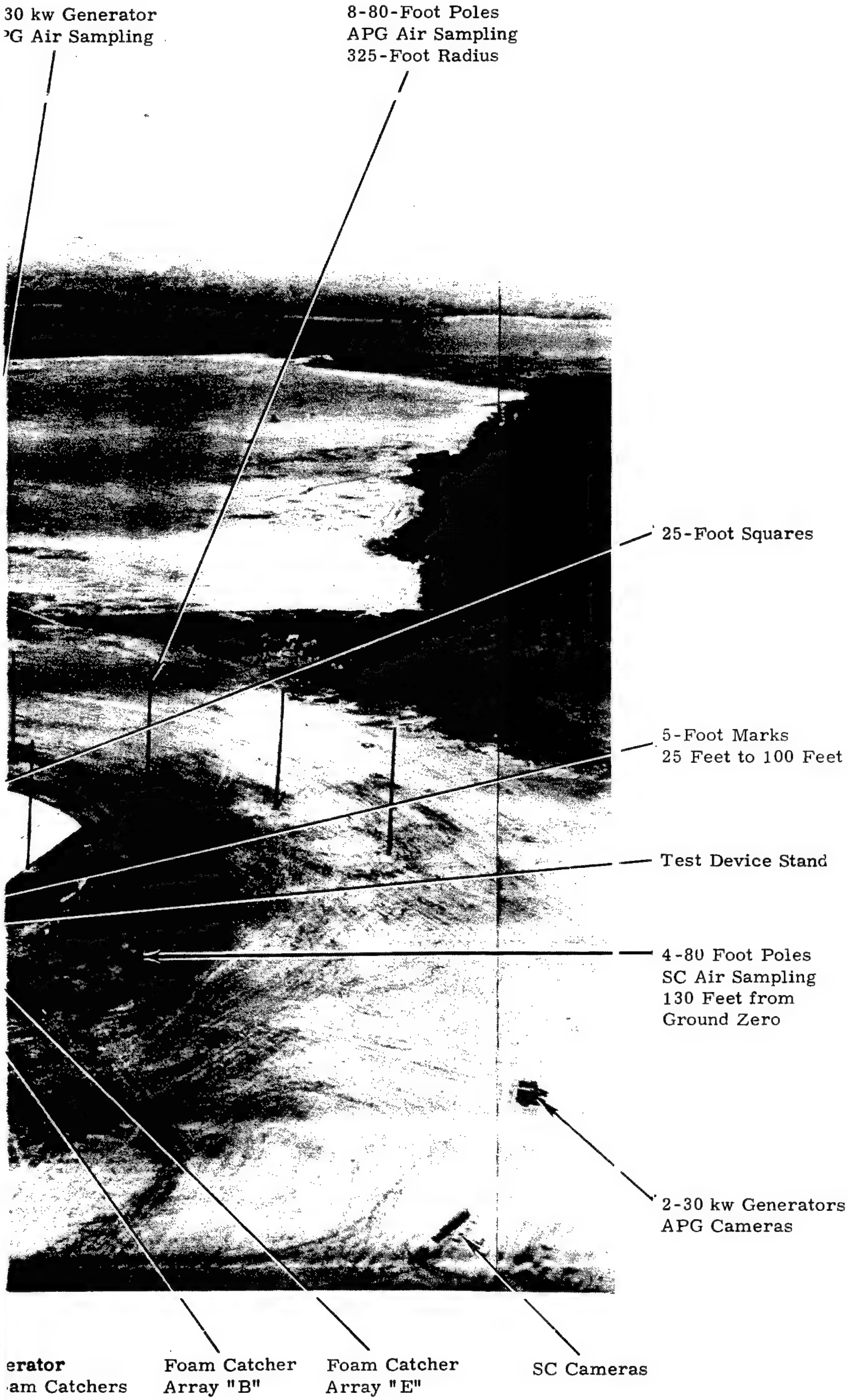


Figure 2. Test Site (Closer View)



ite (Closer View)

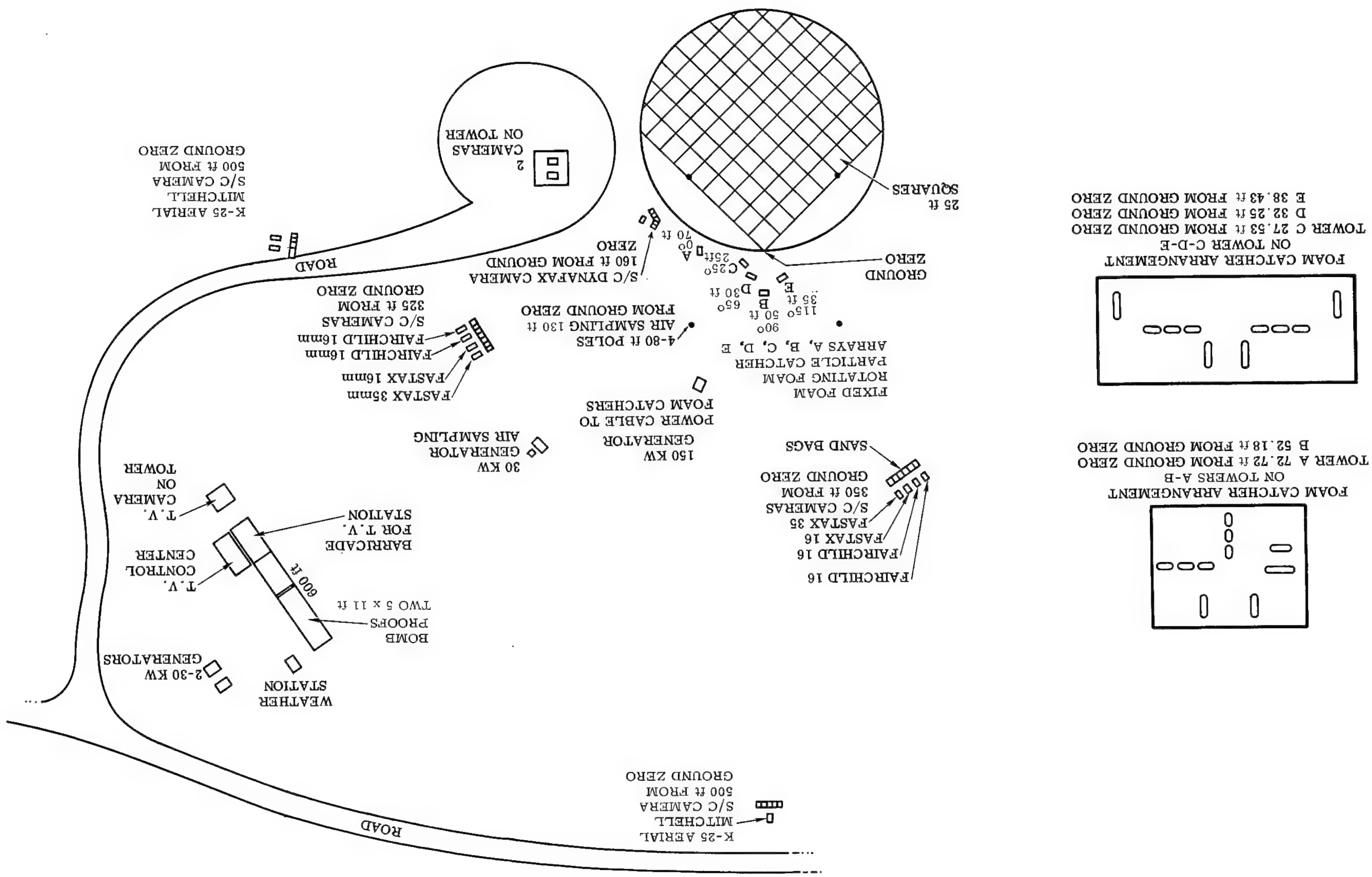


Figure 3. Instrumentation Locations for Sandia Corporation

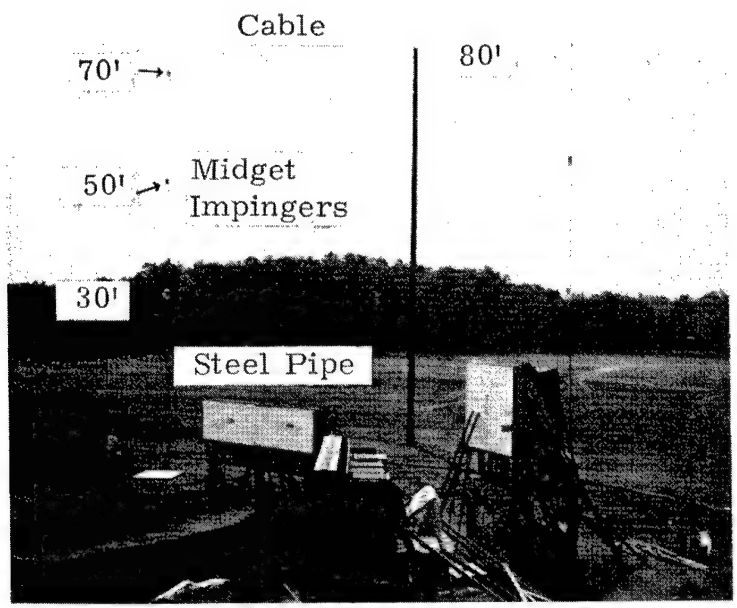


Figure 4. Air Sampling Boxes

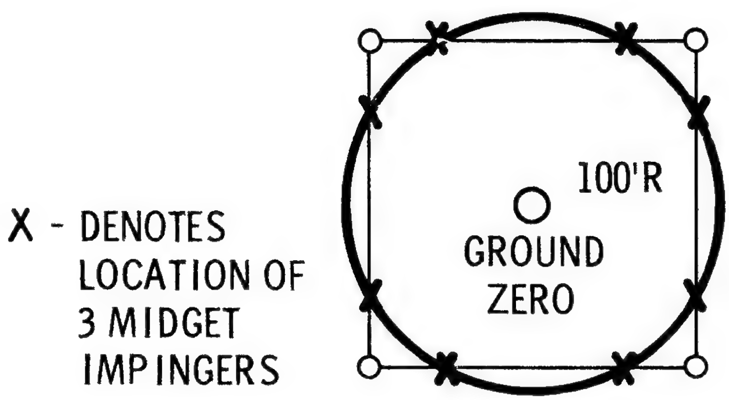


Figure 5. Air Sampler Locations

The individual lines were suspended through pulleys on the overhead cables which permitted the array to be raised and lowered as necessary. Each line was held in place at ground level by means of a 22-foot length of 1-1/4 inch steel pipe. The pipe had a loop welded to one end to which the line was tied; the other end of the pipe was slipped over a 3-foot stake in the ground. The pipe not only held the array line taut, but also prevented fragments from harming the pump motor cords which were threaded through the pipe.

The midget impingers, driven by small 110-volt AC vacuum pumps (Gast miniature pump, 0330-V102A-15), were filled with 10 cc of 1 percent alcohol-water collecting solution. Both pump and impinger were housed in a small wooden box as shown in Figure 6. This sampler is not dependent on wind direction; therefore, no wind orientation device was needed.

B. Pressure Measurement and Photo Resistive Measurement of Case Breakup Time

The blast pressures developed during the destruction of a mockup ROVER reactor were recorded on an Ampex CP 100 Magnetic Tape Recorder (Figure 7). Susquehanna ST-2 pressure transducers were used as the pressure sensors (Figure 8). One thousand feet of Microdot cable connected each transducer to an Endevco Model 2646 MI charge amplifier (Figure 9).

Field calibration of the system was made with a Ballantine Precision Calibrator (Figure 10) which supplied the AC voltage equivalent to the pressures which would be developed by an uncased charge of this size. An Ampex TC-10 calibrator (Figure 11) was used for the initial tape checkout of the center frequency, frequency deviation, and discriminators. A Tektronix Type 321 oscilloscope (Figure 12) was used to monitor the preceding steps.

Laboratory calibration of the system preceded the test. Each transducer was calibrated at 50, 20, and 5 psi. The amplitude and rise time of the calibration pressure pulses were greater than expected during the full-scale test. The transducers were connected to the charge amplifier through 1000 feet of cable, and the voltage generated by the pressure pulse was recorded on a Tektronix 535 oscilloscope. The input to this oscilloscope was modified to have the same impedance as the tape recorder. The amplifier gain control was set and locked at this time, with an output of 1 volt corresponding to the maximum theoretical pressure input value.

Twelve transducers were mounted in the blast area, each 6 feet above ground level. Four transducers were located 20 feet from ground zero (Figure 13 shows a mounted gage): one in a jet, one at 45 degrees between jets, and two at 5 degrees on either side of a second jet. Four more transducers were located 10 feet behind the first four; the remaining four were 10 feet behind them. The pressure transducers were located as in Figure 14; the system schematic is shown in Figure 15. An Ampex ORP-60 Photo Resistive Unit (Figure 16) was to determine time from detonation of the external detonators until break-out of the main case.

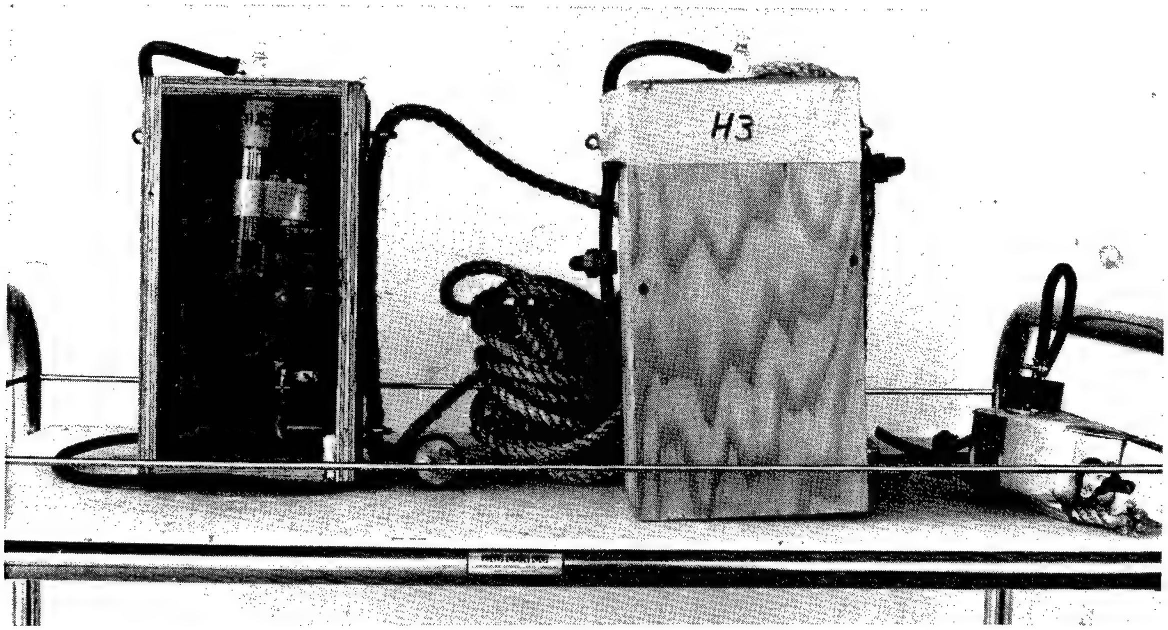


Figure 6. Midget Impinger in Box and Midget Impinger Box

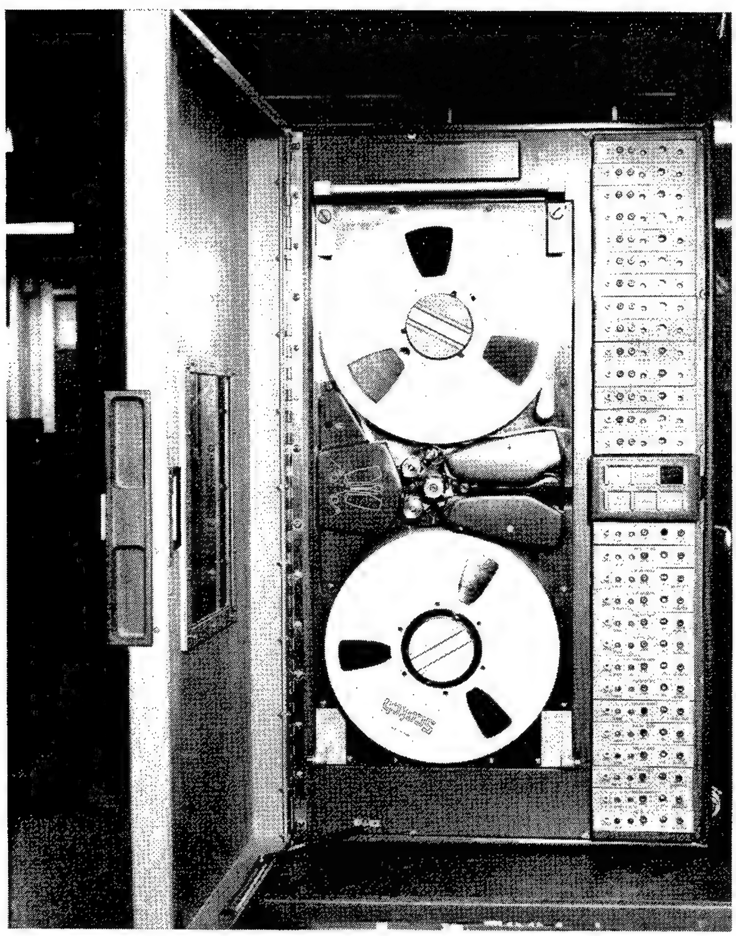


Figure 7. Ampex CP 100 Tape Recorder

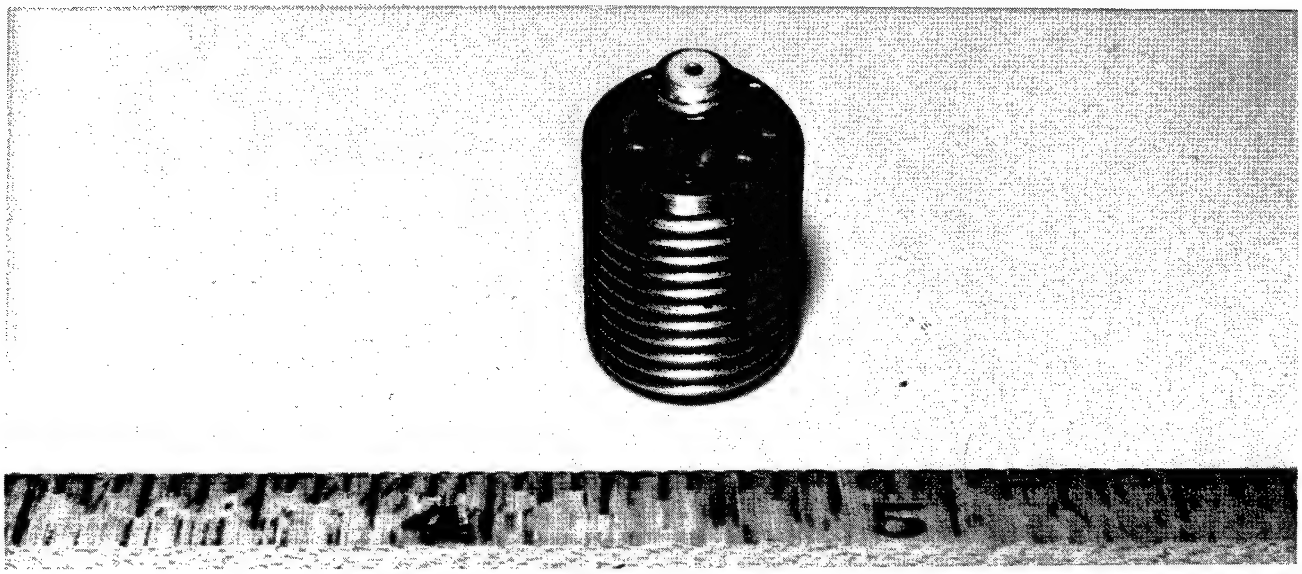


Figure 8. Susquehanna ST-2 Pressure Transducer

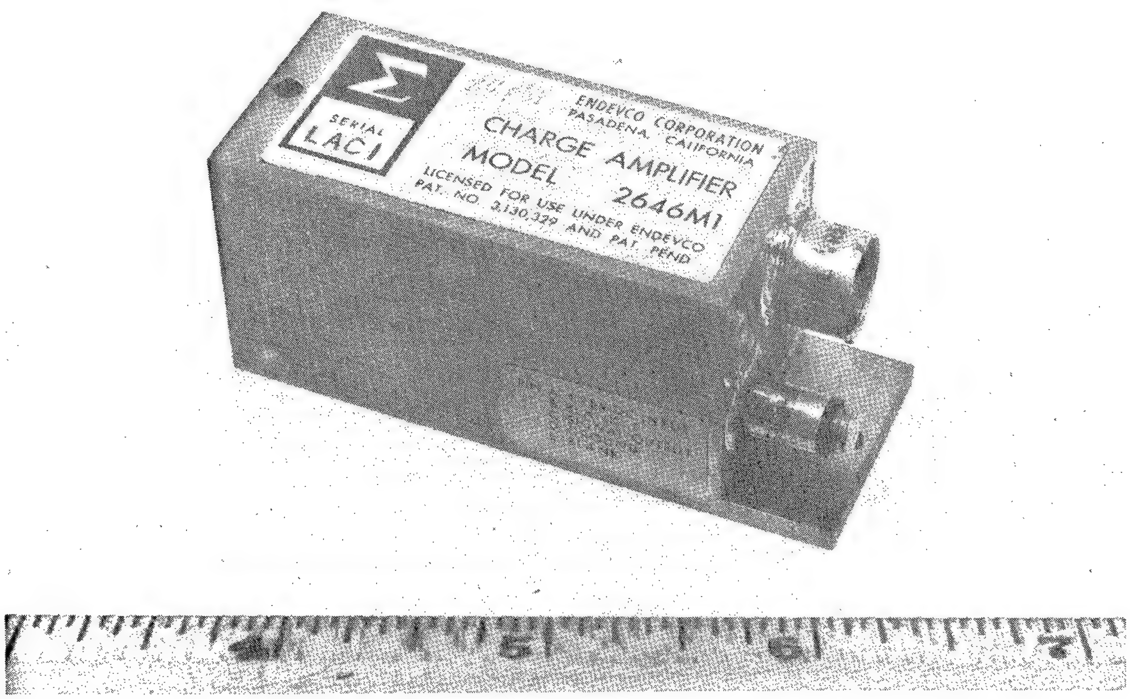


Figure 9. Endevco Model 2646 MI Charge Amplifier

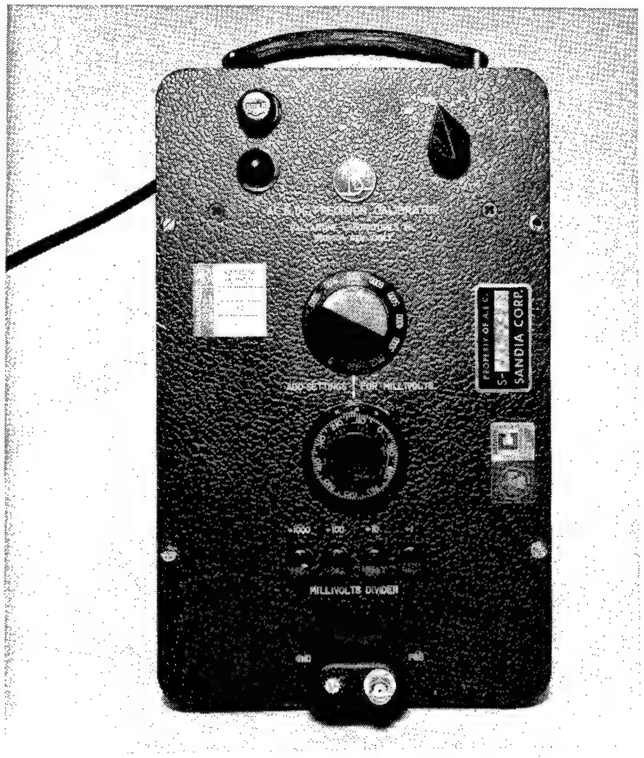


Figure 10. Ballantine Precision System Calibrator

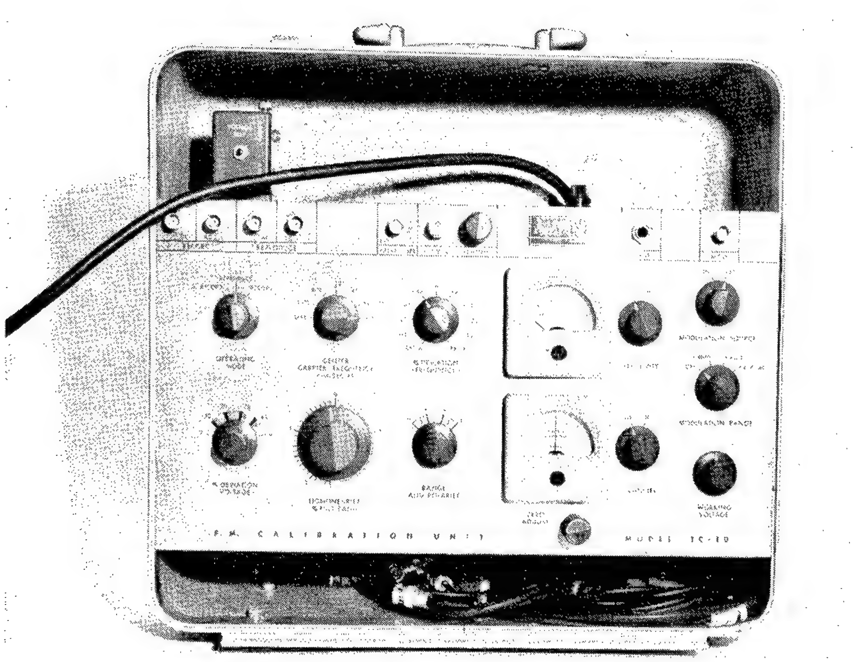


Figure 11. Ampex TC-10 Calibration Unit

Figure 12. Tektronix Type 321 Oscilloscope

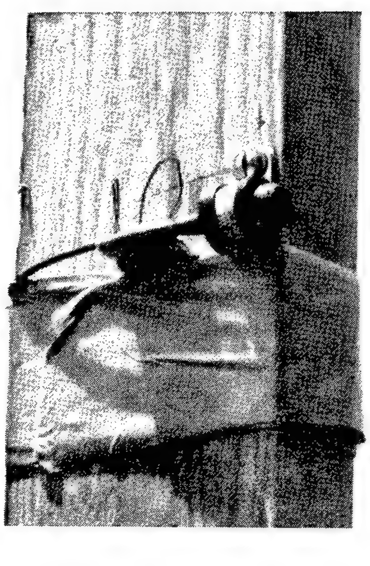


Figure 13. Mounted Pressure Transducer

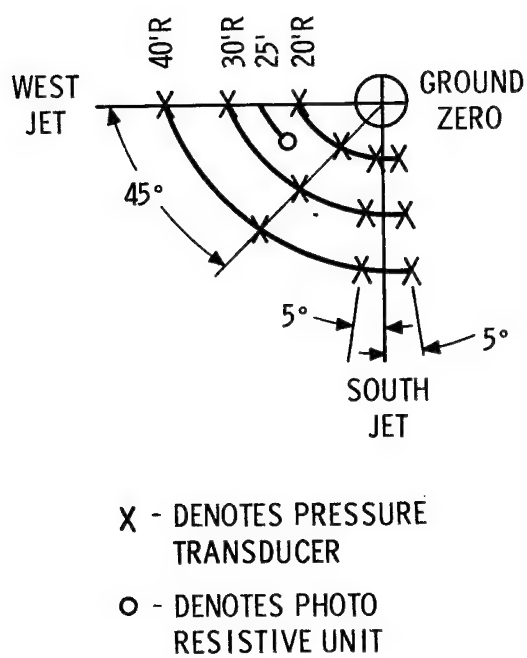


Figure 14. Pressure Transducer Locations

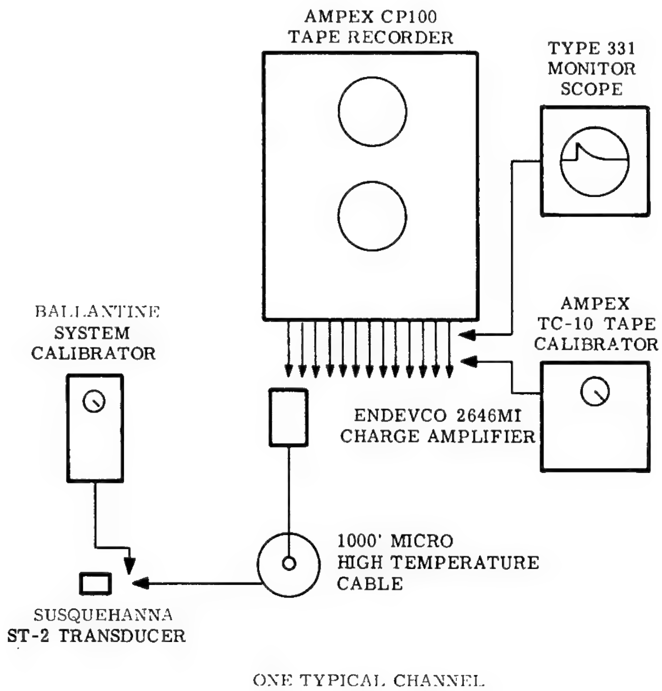


Figure 15. Pressure Transducer System Schematic

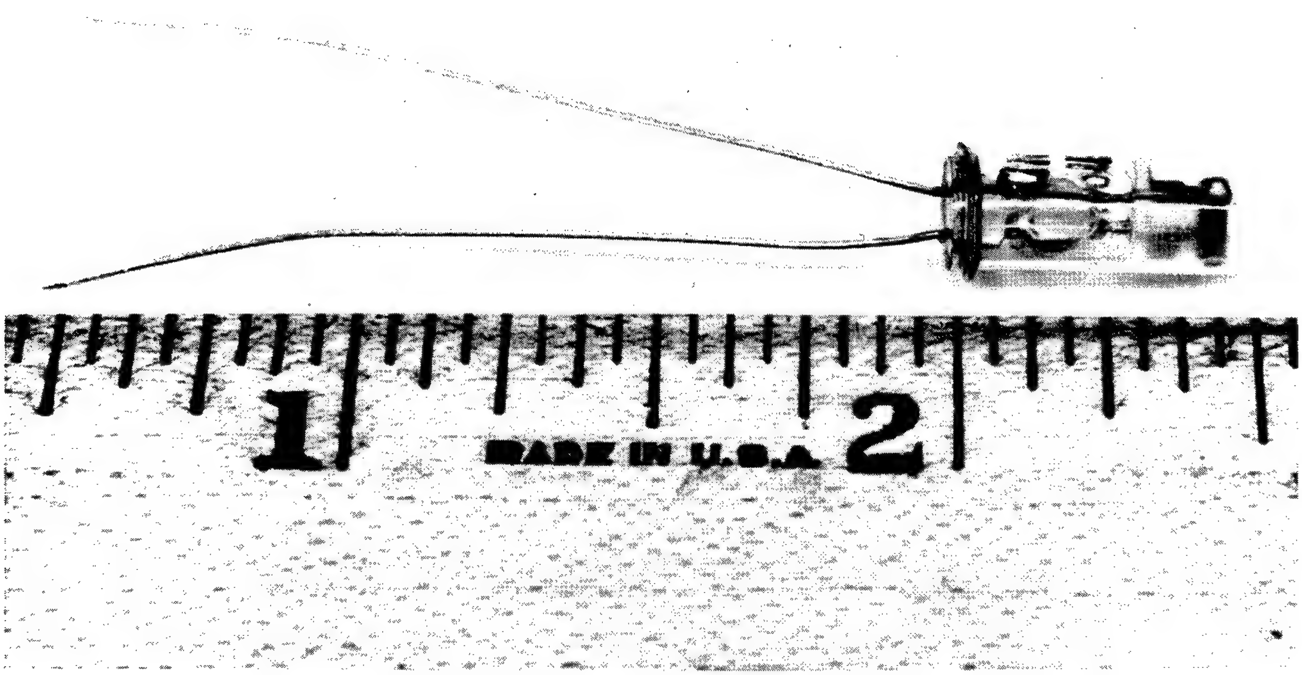


Figure 16. Ampex ORP-60 Photo Resistive Unit

C. Glass Rod Velocity Measurements

To measure the velocity of the particles resulting from the destruction of the test vessel, conducting glass rods were employed (Figure 17). These rods were constructed of 3/16 x 8-inch glass tubing painted with a conductive paint which provided a path of electrical continuity between each end. Measurements revealed that the resistance of each 8-inch rod was approximately 2 ohms.

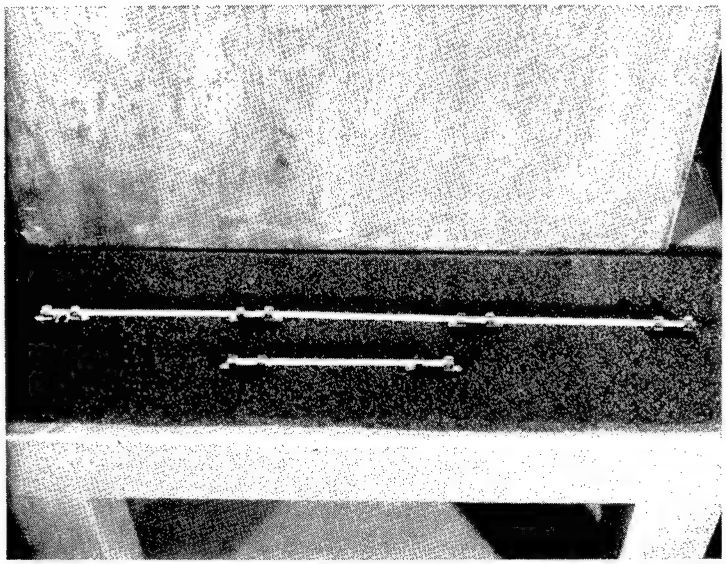


Figure 17. Glass Rods with Fuse Clips

Electrical connections were made to the rods through fuse clips. A clip was attached to each end of the rod, and all wiring connections were made to the clip (Figure 17). Figure 18 is a schematic of the glass rod system.

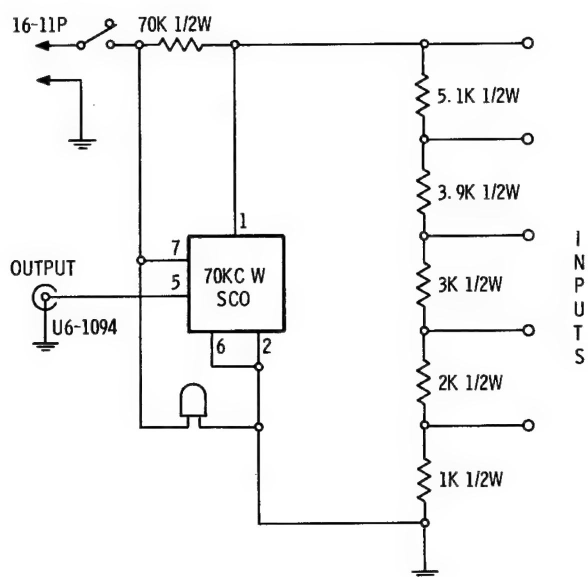


Figure 18. Schematic of Glass Rod Velocity Measuring System

The rods were positioned at various points along the south and west jets (Figure 19) and above and below the test vessel (Figure 20). Some glass rods were mounted on a post (Figure 21), and others were adjacent to the pressure vessel (Figure 22). The rods along the jets were placed on 2 x 4-inch supports which positioned the rods in the path of the jet. To provide a larger target area, the rods along the jets were 24 inches long (three 8-inch rods bonded end to end). Along the west jet a rod was positioned at the surface of the test vessel; others were placed every 10 feet from 10 to 70 feet. Along the south jet a rod was placed on the surface of the test vessel with others at 10, 30, and 50 feet. The rods placed against the skin of the test vessel gave an indication of the time delay from detonation to the breakup of the test vessel case.

The rods above and below the test vessel, as shown in Figure 20, were positioned at the top of the test vessel to measure the velocity of the nozzle and at the bottom of the test vessel to measure the velocity of the dome.

A rod was connected across each input of the circuit shown in Figure 18. When the rod was hit by debris, it shattered and thus removed an electrical short from a particular resistor in the circuit which in turn caused a change in the input voltage to the voltage controlled oscillator. This change in voltage changed the frequency of the output signal of the voltage controlled oscillator which was recorded on magnetic tape. To accommodate the 20 glass rods used for velocity measurement, five separate channels were employed.

Also recorded on the magnetic tape was a timing fiducial signal which indicated the time of detonation of the four charges in the test vessel. From these data and the known distances of separation between rods, an average velocity can be calculated.

D. Rotating Polystyrene Foam Particle Collectors and Velocity Measuring Devices

All particle collectors and velocity measuring devices were moved in by truck and placed on stands by crane.

1. Single Disc Rotating Velocity Measuring Device

This device was designed to serve a dual function: (1) to measure the time of arrival of particles from which the average velocity can be calculated, and (2) to catch and preserve the particles that reach it. This unit consists of a flat disc of 1.9 lbs/ft^3 polystyrene foam, 8 inches thick and 15 inches in diameter (Figure 23). The disc is driven at a constant rotational velocity of 1725 rpm by a 3/4 hp 220 volts AC single phase electric motor. The rotating disc and motor are housed in a fabricated aluminum cabinet measuring 26 inches long, 18.5 inches high, and 18 inches wide, the front face of which contains a 4.75 x 1 inch stationary slit which faces the explosion center and allows a debris sample to enter the polystyrene foam disc (Figure 24). A dual spark source, one from a modified transistorized automobile ignition system and one from a high-voltage capacative discharge system (Figure 25) provided a zero time mark on heat sensitive recorder tape attached to the periphery of the disc.

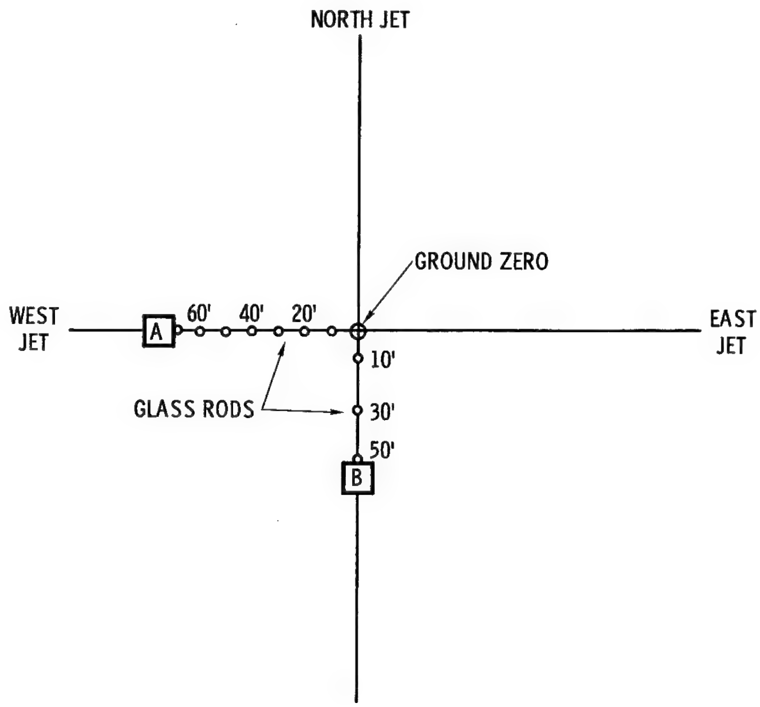


Figure 19. Location of Glass Rods Along Jet Lines

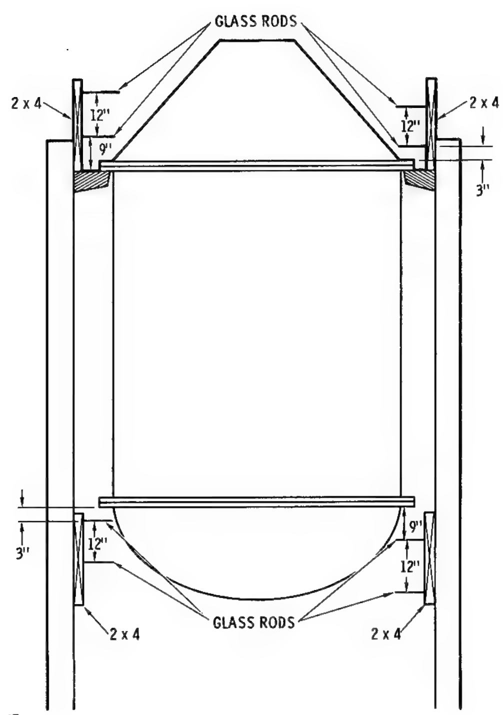


Figure 20. Sketch of Glass Rods Positioned Above and Below the Pressure Vessel

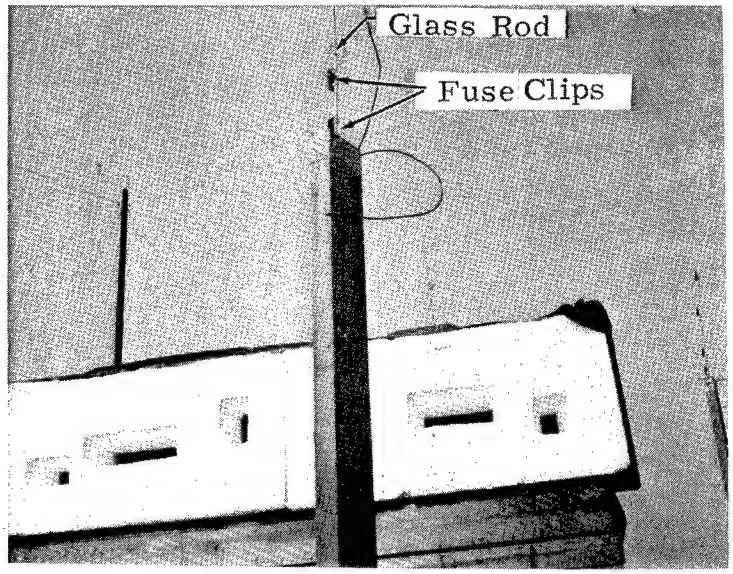


Figure 21. Glass Rod Velocity Device on Post

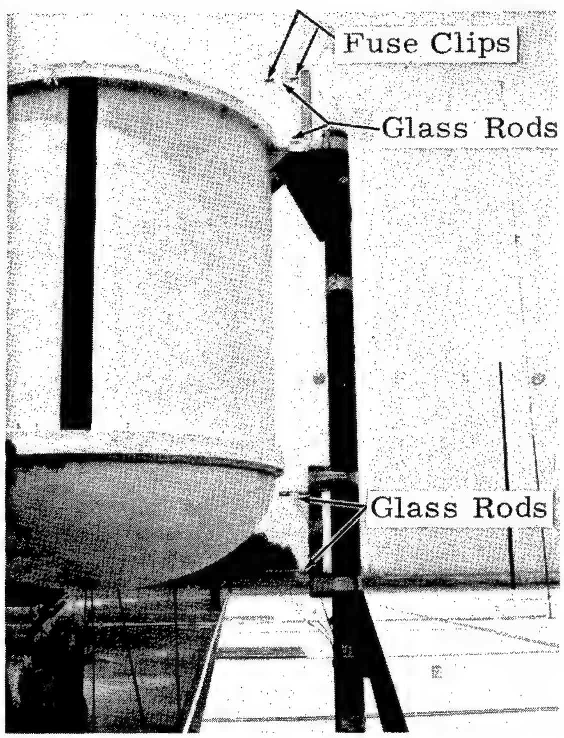


Figure 22. Glass Rods Positioned Above and Below Pressure Vessel

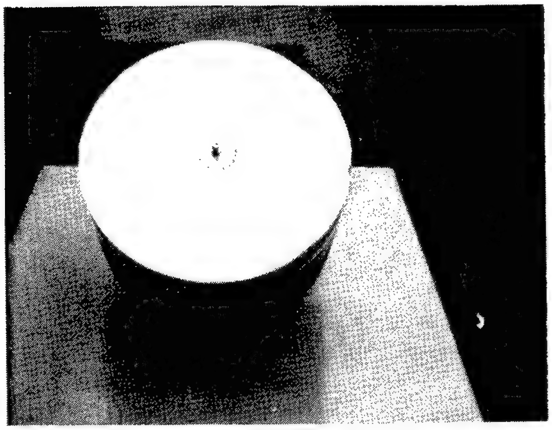


Figure 23. Rotating Disc Foam

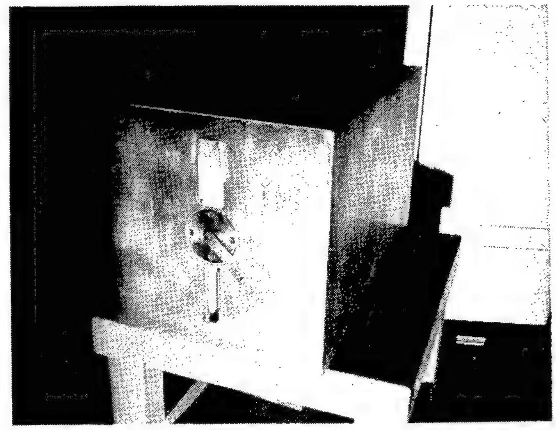


Figure 24. Rotating Disc Velocity Gage

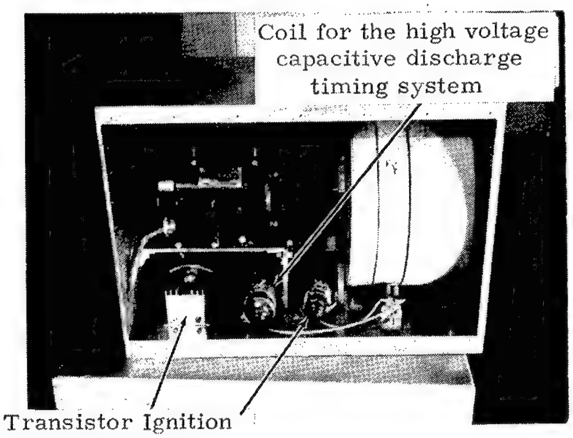


Figure 25. Dual Spark Source For Disc Velocity Gage

A line of particles from the explosive debris cloud is permitted to enter through the stationary slit and embed in the rotating polystyrene foam disc. With the disc velocity known and the angle the particles (debris) make with respect to the zero time mark, Time T was calculable. The distance D was determined by measurement; therefore, the average velocity Va can be determined by the equation: $Va = D/T$.

2. Rotating Drum Velocity Measuring Device

The rotating drum velocity device was designed to perform the same functions as the disc velocity device described above. Its principle and operation are the same except that the particles enter a 1 x 18-inch slot and strike the drum normal to the drum surface and axis. The drum is polystyrene foam 18 inches long by 21 inches in diameter. Total weight of the rotating drum assembly is approximately 210 pounds. The drum and drive

are housed in an aluminum skin and stringer structure stressed for 20 psi overpressure. Figure 26 shows one of the 10 drum collectors used during the destruct test, Figure 27 shows the collection surface, and Figure 28 shows the components of the dual spark source timing systems.

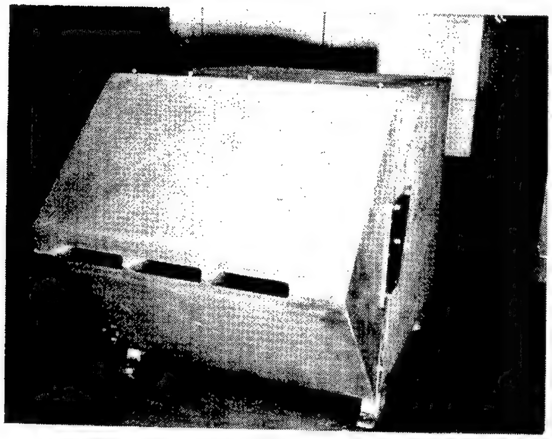


Figure 26. Rotating Velocity Gage

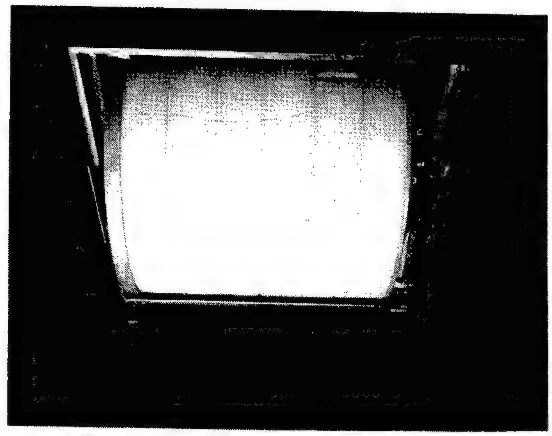


Figure 27. Rotating Drum Foam

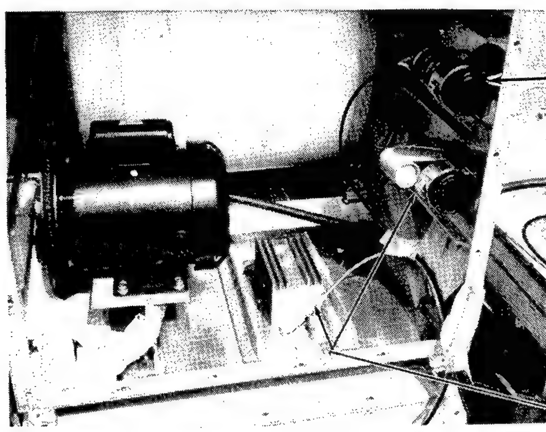


Figure 28. Dual Spark Source for Drum Velocity Gage

3. Rotating Twin Disc Velocity Measuring Device

The twin disc velocity device (Figure 29) was designed to obtain four information bits: (a) average velocity, calculated by measuring time of arrival of particles, (b) final velocity, calculated by determining the time interval between particle penetration of the front disc and rear disc, (c) initial velocity, calculated by using the average velocity and the final velocity found in (a) and (b); and (d) capture and preservation of the particles.

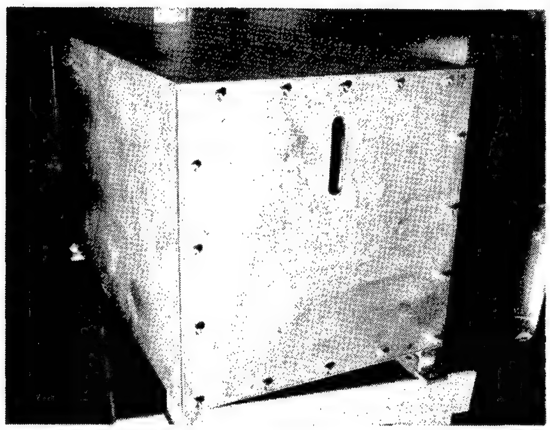
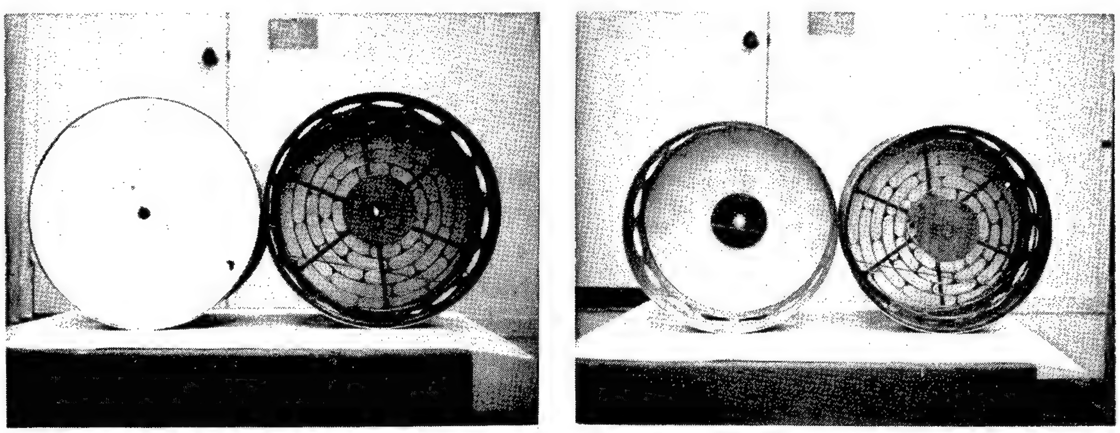


Figure 29. Twin Disc Velocity Device

As shown in Figure 30, the twin disc velocity device consists of two spoked discs, spaced 8 inches apart on a common driver shaft. Paper is glued over each disc. The rear disc is backed with polystyrene foam which captures and preserves the particles.

Rotating Twin Disc Assembly



With Paper on Front Surface

Without Paper on Front Surface

With Front Surface Removed

Figure 30. Twin Disc Velocity Device Internal Assembly

Dual spark sources are located inside the housing along the periphery of the disc assembly and are arranged to mark the rotating assembly when energized at the time of detonation (time zero). The disc assembly, motor, and time mark systems are housed in an aluminum skin and stringer structure stressed to withstand 20 psi overpressure. Figure 31 shows the components of the timing system.

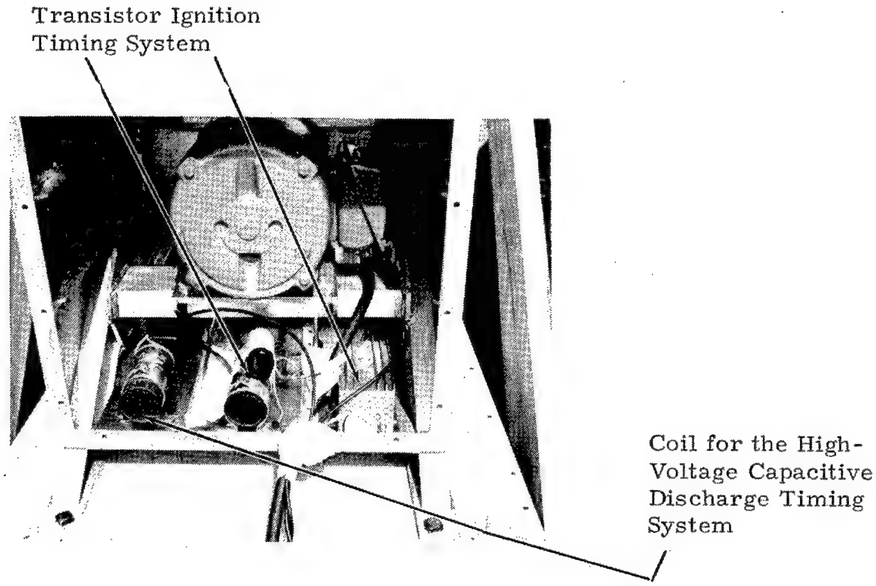


Figure 31. Dual Spark Source for Twin Disc Velocity Device

A line of particles from the explosive debris cloud is permitted to enter through a stationary slit on the front cover. The particles pass through the paper on the front and rear discs and then embed in the foam. The time of particle arrival can be calculated by measuring the particle angular displacement with respect to the zero time mark and the rotational speed. The average velocity can be calculated from a knowledge of the time of arrival and the distance the particles traveled from the point of detonation to the sampler.

The final velocity is calculated from the measured displacement of the particle penetration imprint on the front disc paper with respect to the imprint on the rear disc paper, the distance traveled between the two disc papers (8 inches), and the rotational speed.

The initial velocity can be computed using the calculated average velocity and final velocity in the formula:

$$Va = \frac{Vi + Vf}{2}$$

where Va = average velocity

Vi = initial velocity

Vf = final velocity.

Each particle was recovered from the foam and its size and shape correlated with its three velocities.

4. Fixed Foam Particle Collectors

The polystyrene foam plastic placed in front of the rotating foam collectors had a threefold purpose: (a) collect the debris from the destruction of the propulsion engine, (b) act as an energy absorption media to protect the rotating foam collectors from large missiles, and (c) show the relative quantity of debris in the jets and in between jets.

The foam plastics used were: foam tyril 80, styrene-acrylonitrile weighing 0.8 lb/ft^3; and styrofoam blocks, FR insulation board weighing 1.9 lb/ft^3.

Figure 32 shows the foam plastic on the front of the arrays of rotating foam particle collectors. Stands "A", "B", "C", and "E" used the 0.8 lb/ft^3 material, and stand "D" used the 1.9 lb/ft^3 material.

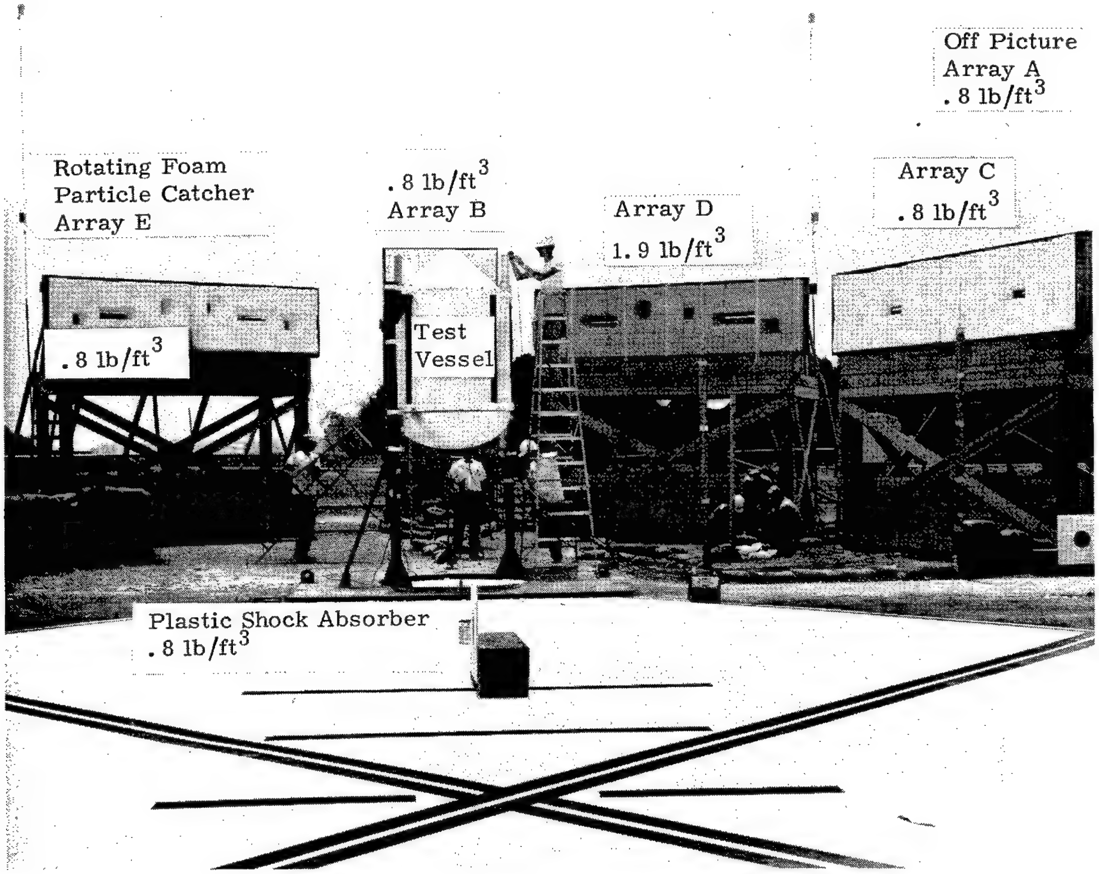


Figure 32. Fixed Foam Plastic

The polystyrene foam was also used as a shock absorber in the 6 x 6 x 4-1/2-foot deep hole beneath the mockup propulsion engine (Figure 32). The foam was positioned to absorb the energy from the moving pressure vessel dome and to prevent the dome from digging up earth which would contaminate the graphite samples.

E. Rotating Foam Particle Collector Motor Control and Timing Systems

1. Motor Control System

The full-scale ROVER test was partially instrumented by 30 rotating polystyrene foam particle collectors, each driven by an electric motor. To facilitate the control of these collectors, a system was designed to permit individual control of each motor. The power to each motor was furnished through a motor starting relay controlled from a bombproof central control point. Figure 33 is a schematic of the motor starting system. This system for individual control facilitated the checkout of the collectors by making it possible to operate any number of collectors at a given time.

To keep the run-time of the collectors as short as possible, the motors were started immediately before the test. To avoid the problem of a large transient current, the motor controls were used to start the motors individually, allowing sufficient time between successive motor starts for the transient current to partially dissipate.

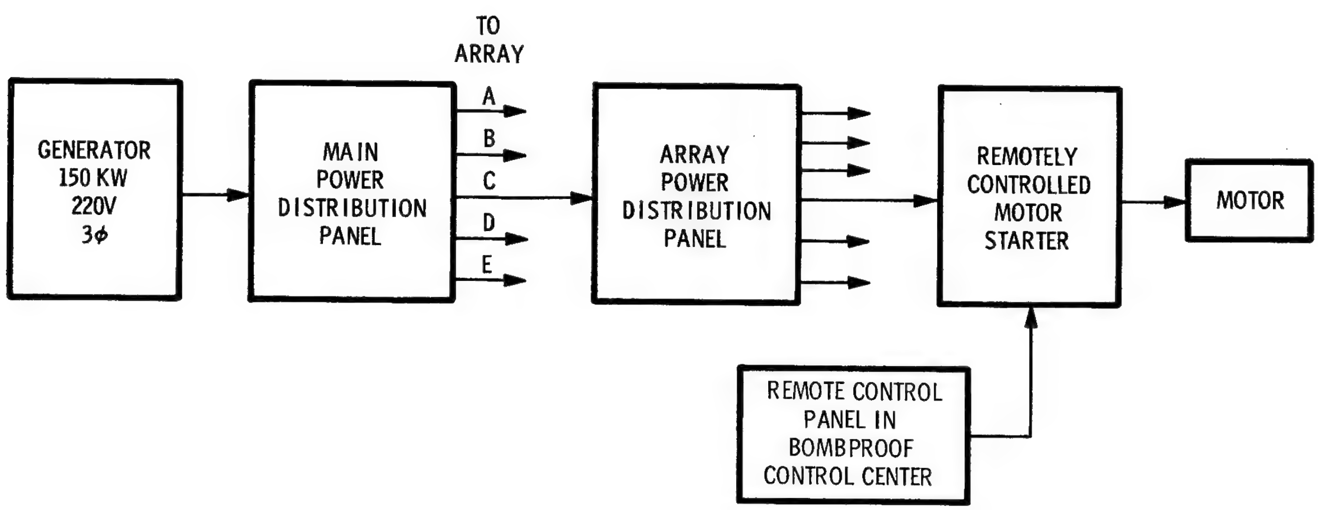


Figure 33. System for Remote Control of Catcher Motors

2. Timing Systems for Rotating Polystyrene Foam Particle Collectors

A timing reference point was placed on the rotating drums and discs so the debris velocity could be determined. The fiducial mark was recorded on oscillograph paper which was attached to the rotating devices. Two layers of oscillograph paper were used; each layer was a different type paper. The bottom layer was voltage sensitive and the top layer pressure and temperature sensitive. When an electric arc was passed through the two layers of oscillograph paper, a distinct mark was left. This point was most prominent on the reverse side of the pressure and temperature sensitive paper which was in contact with the voltage sensitive paper. The point was also readily distinguishable on the face of the voltage sensitive paper (Figure 34).

Two separate systems were used to provide the timing fiducial points. Both systems operated on the principle of capacitor discharge through an automobile ignition coil. One system (Figure 35) consisted of a field test high voltage capacitive discharge system which distributed the energy from the discharge of a 7-microfarad capacitor charged to approximately 2500 volts to 16 separate outputs. The output of the system was the input to the ignition coil which produced an arc from an electrode to the surface of the rotating device. This arc passed through the two layers of oscillograph paper on the surface of the device to provide a distinct record of the position of the drum or disc at the time of firing.

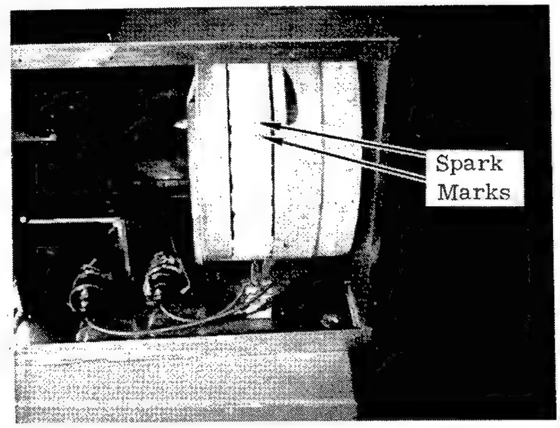


Figure 34. Oscillograph Paper Showing the Mark from the Dual Spark Source

An alternate system was designed to put ten timing marks, 1 millisecond apart, on the rotating discs and drums. This system consisted of a sequence timer and a modified automobile transistorized ignition system (Figure 36) with an output that was the input to an automobile ignition coil which provided an arc for marking the oscillograph paper on the drums and discs. To allow the marks to be applied during the time the particles were actually arriving, the marks were delayed a calculated time from T_o -- the time of detonation.

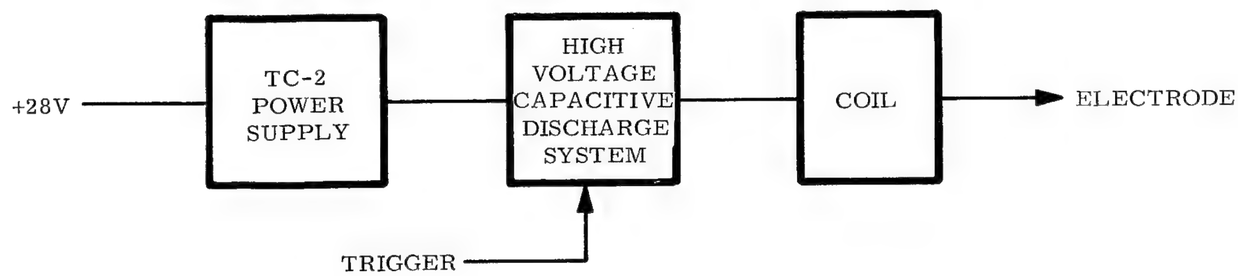


Figure 35. High Voltage Capacitive Discharge Timing System

The sequence timer (Figure 36) was actuated by the fire signal at T_o. The fire signal was the input to the one shot which initiated the 1 kc clock. The digital delay counter then counted the clock pulses for the desired delay time. After the delay time had elapsed, the control gate was opened by the control gate flip-flop, and the clock pulses were applied to the level converter which changed the pulses from logic level to pulses of sufficient amplitude to drive the transistorized ignition system. The input to the level converter was also the input to a decade counter which closed the control gate after ten pulses had been applied to the output.

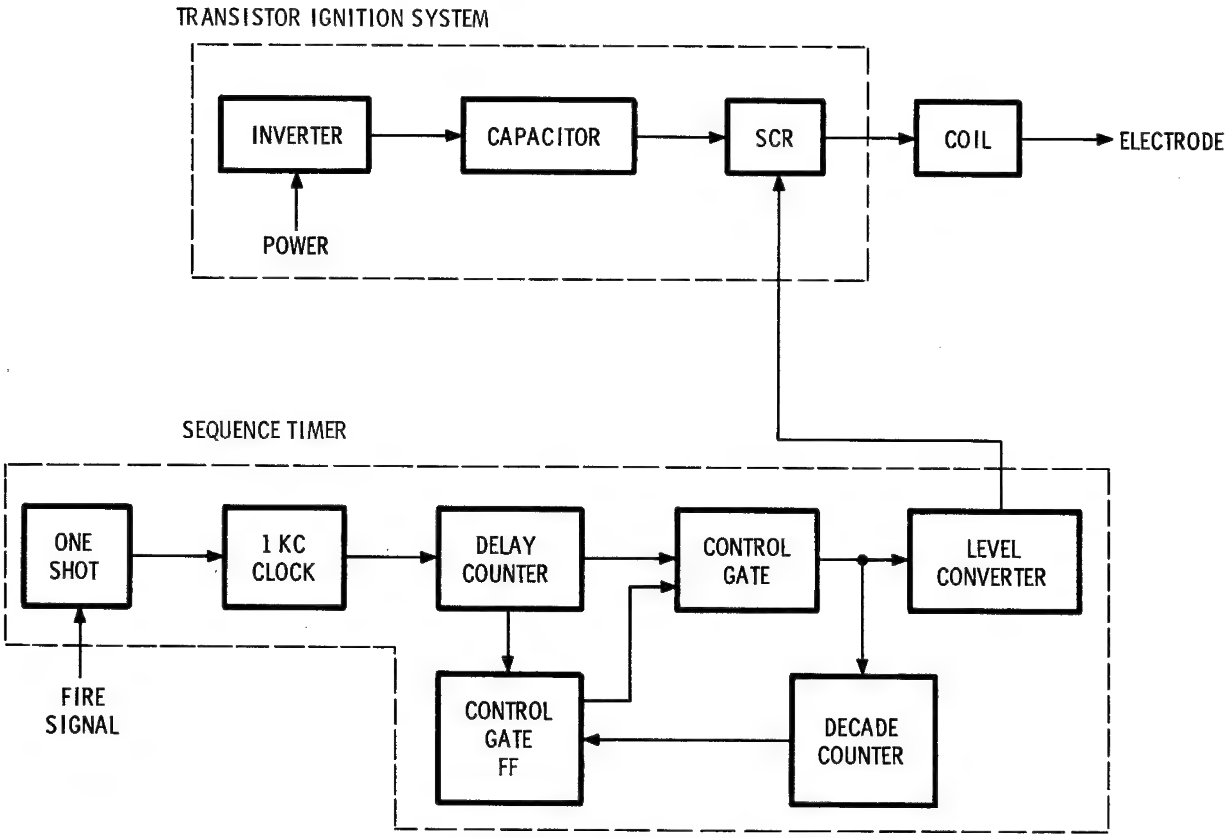


Figure 36. Ignition Unit Timing System

The commercial transistorized ignition system consisted of a transistor inverter, a storage capacitor, and a silicon controlled rectifier (SCR) to discharge the charged capacitor into the coil. The commercial ignition systems were modified so that they could be fired electronically by the sequence timer. The output of the ignition system was the input to a standard 100 to 1 turns ratio automobile ignition coil which stepped up the voltage to approximately 40,000 volts. This voltage was sufficient to cause an arc between the electrode and the surface of the rotating disc or drum.

F. Photographic Instrumentation

The full-scale test was photographically instrumented with 16 cameras. Figure 37 shows the kinds of cameras used, the camera positions in relation to ground zero, and their distances from ground zero.

All of the instrumentation cameras were controlled by a solid-state 10 channel countdown generator (providing millisecond resolution) designed and manufactured by Sandia Corporation (Figure 38).

Before the test, channels 1 and 2 were assigned to trip Dynafax camera shutters and channel 3 to start the Mitchell and K-25 cameras. Channels 4 and 5 were assigned to start the south and west bank of cameras. Channel 6 was assigned to provide the Aberdeen Photo Instrumentation Group with a switch closure.

Channel 10 was used as the "0" time or firing channel. Channels 7, 8, and 9 were not used.

The firing procedure was started at minus 5 minutes. Every minute thereafter was announced on the radio and public address system. At the count of minus 1 minute, the Dynafax cameras were manually switched on and the firing switch was enabled (Figure 39). Minus 10 seconds signaled the start of the countdown generator which performed the events programmed into it and completed the operation.

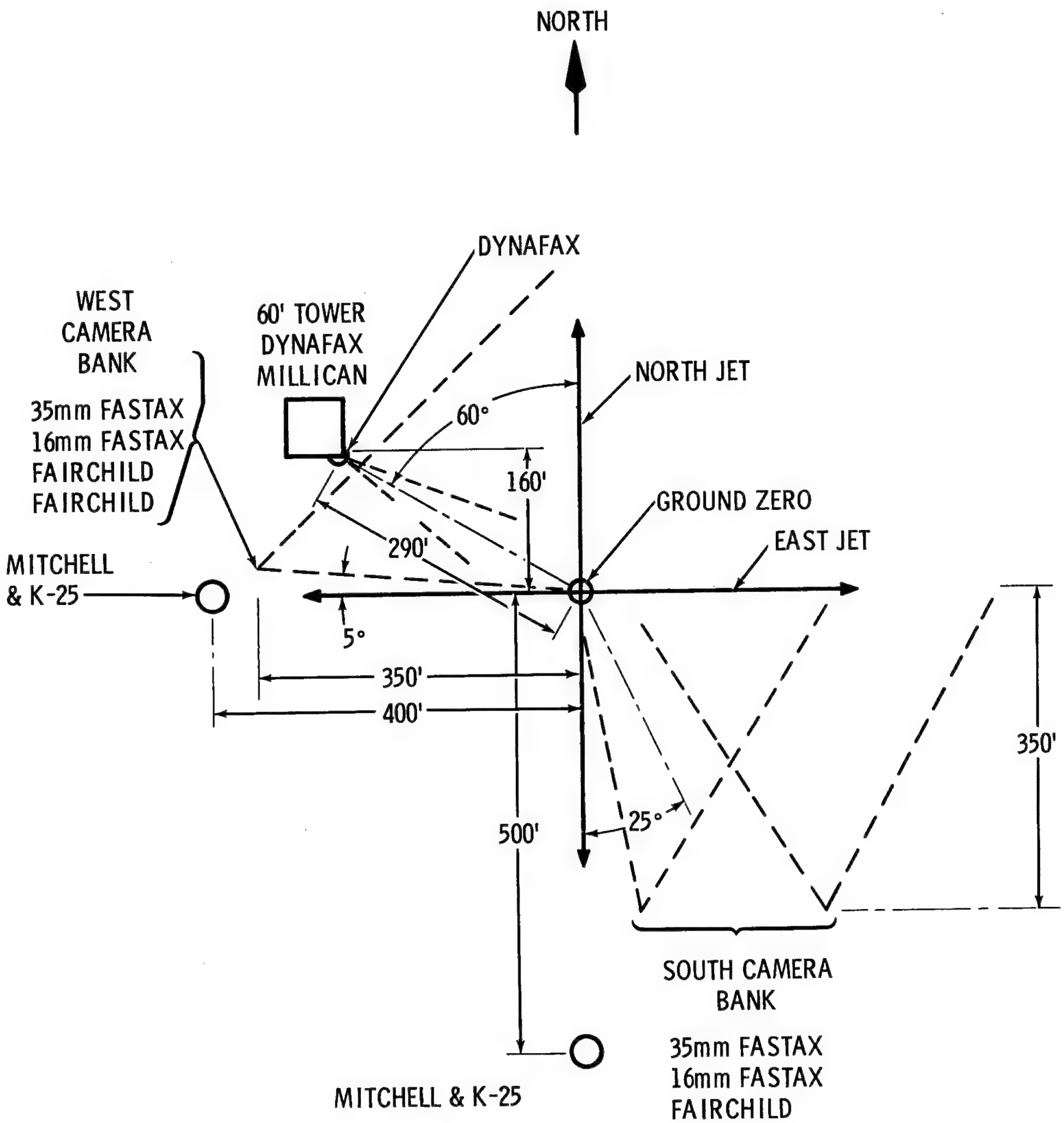


Figure 37. Cameras and Camera Positions

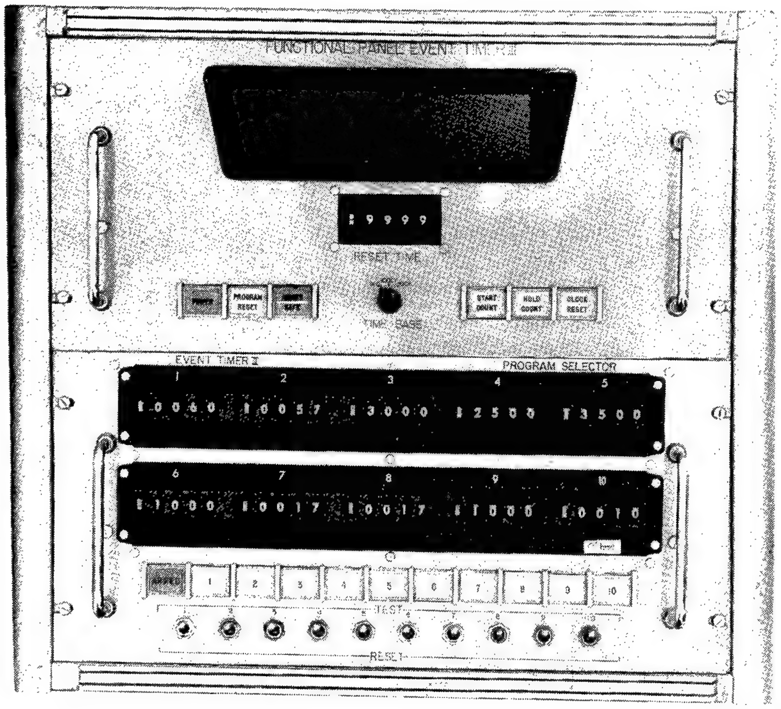


Figure 38. Ten-Channel Countdown Generator

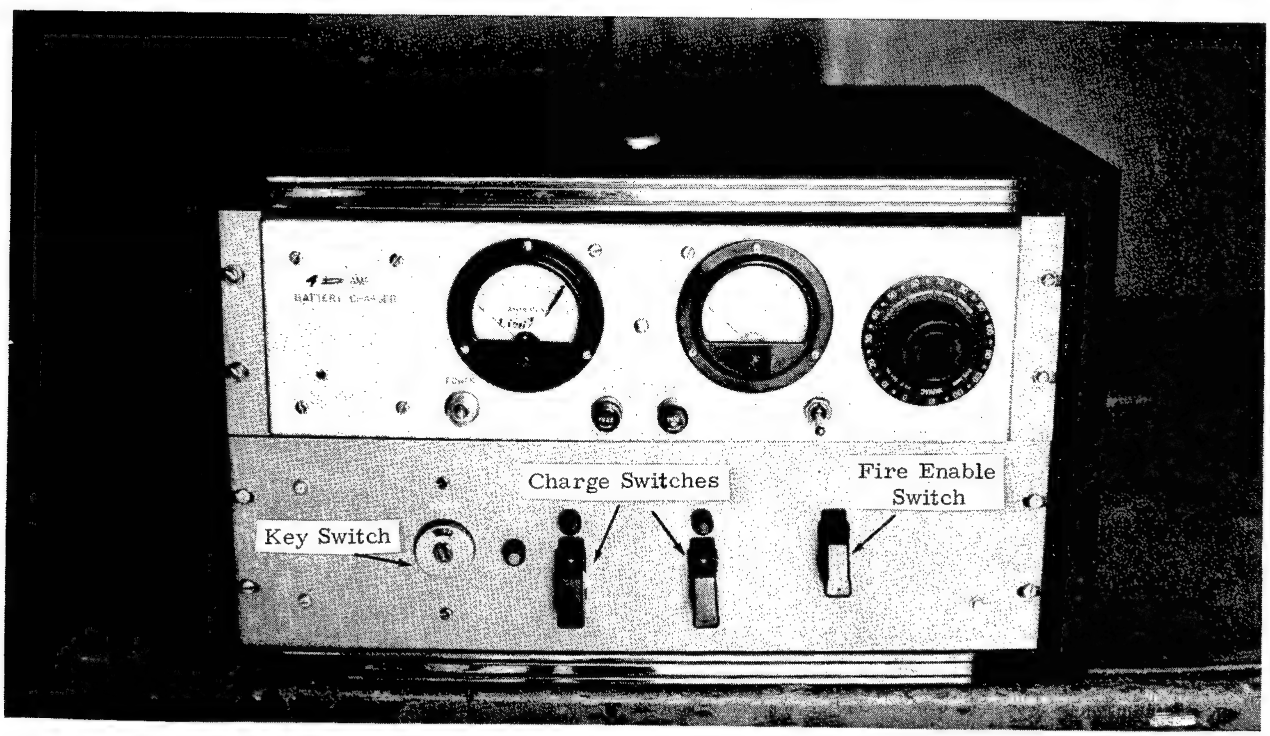


Figure 39. Firing Control Panel

At "0" time the countdown generator provided a switch closure to the firing unit which dumped 2.5 kilovolts into the detonators to fire the unit. All the times programmed into the countdown generator use this "0" time as a reference for camera starting and shutter openings.

In addition to the 16 cameras used on the ground, a hand-held Mitchell camera was used to photograph the destruct event from a helicopter.

Description of Mockup ROVER/NERVA Space Propulsion Engine

The mockup engine was assembled from reject components, where available, and from simulated components. Small parts were omitted, and only those components were simulated that were expected to have an influence on the debris pattern. The assembled mockup engine was supported on an assembly stand (Figure 40), and the assembled and instrumented mockup engine was placed on a firing stand (Figure 41). The dome of the mockup engine is shown, before and after installation of polyurethane foam plastic, in Figure 42. The foam plastic simulated the shield material normally contained in the dome.

The simulated nozzle used in the assembly is shown in Figure 43 and the center section of the pressure vessel in Figure 44. Figure 45 shows an internal view of the pressure vessel after the simulated reflectors, dome (not visible), and core support plate have been installed.

Figure 40. Assembled Mockup Engine on Assembly Stand

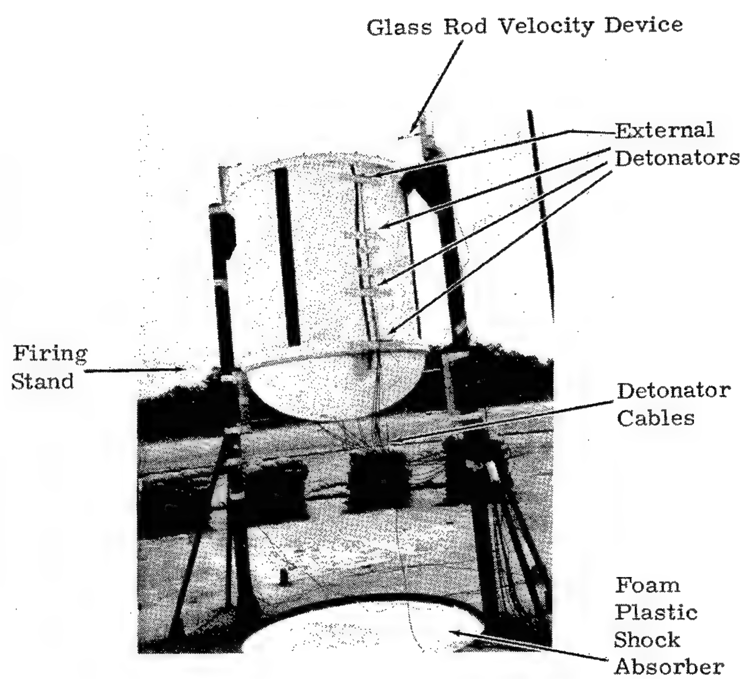
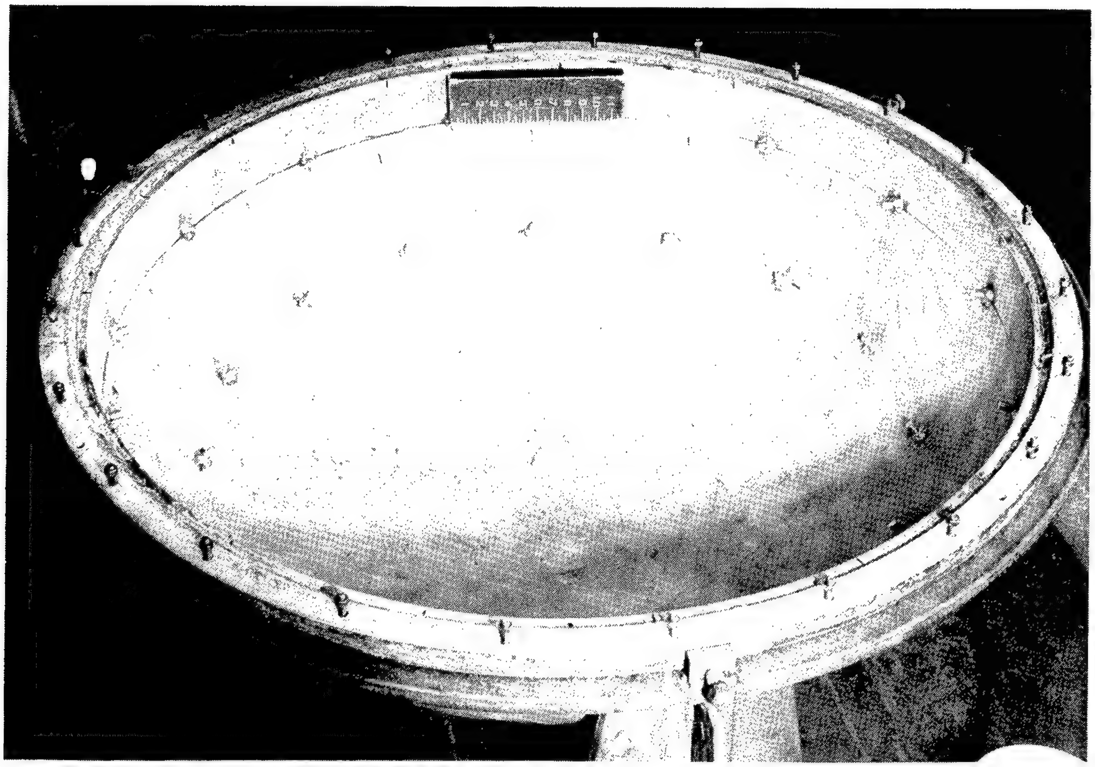
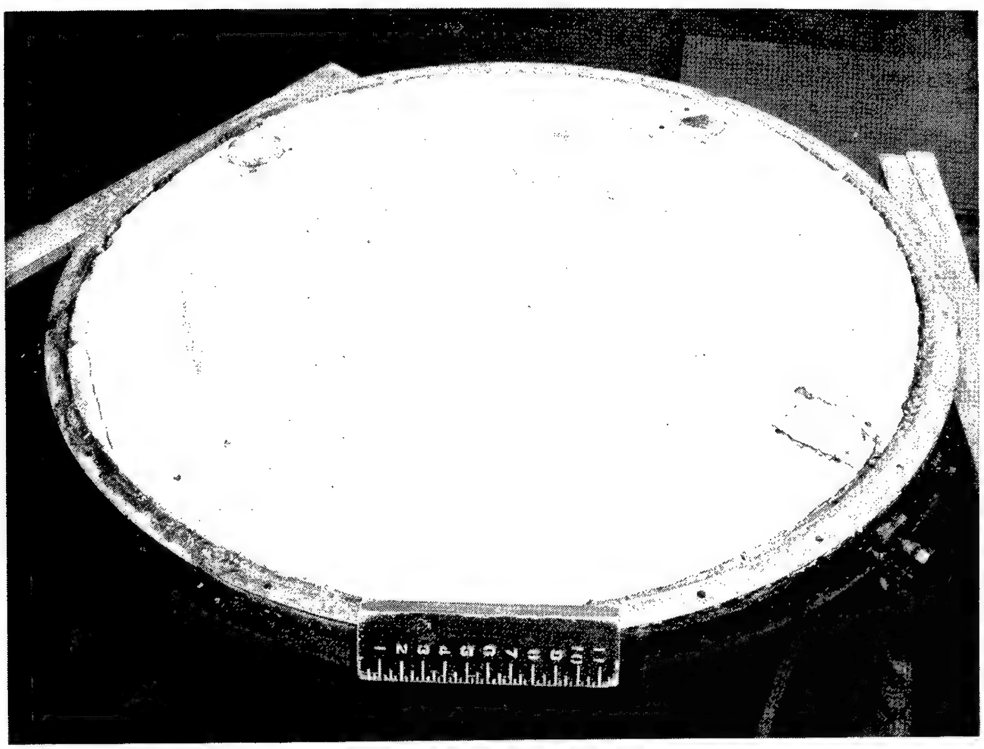


Figure 41. Assembled and Instrumented Mockup Engine on the Firing Stand



A. Before Installation of the Foam Plastic Shield



B. Foam Plastic Shield in Place

Figure 42. Pressure Vessel Dome Before and After Installation of the Polyurethane Foam Plastic Shield

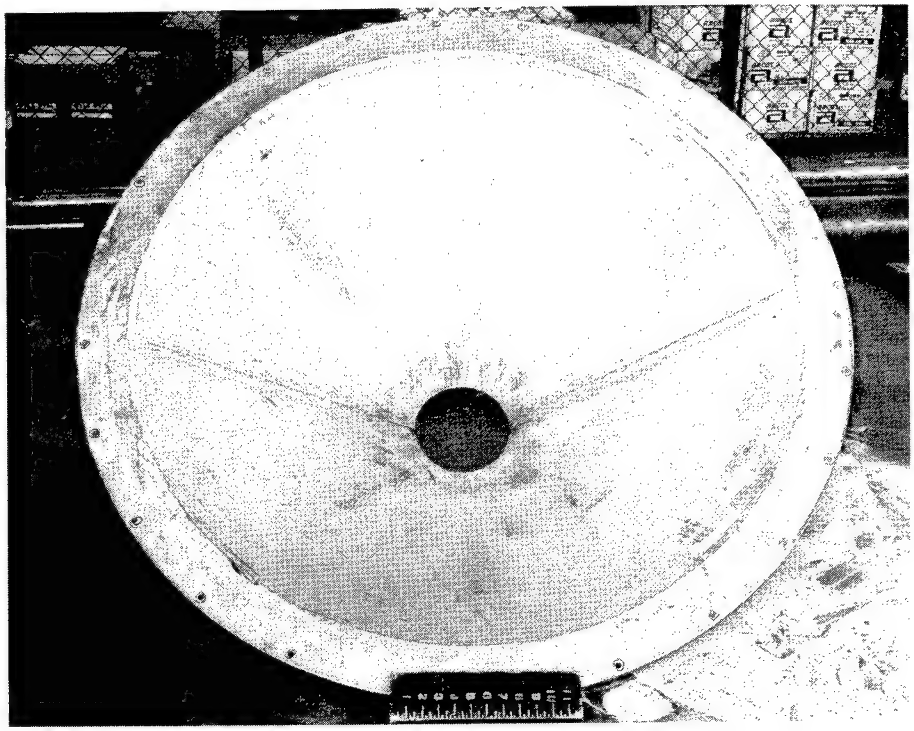


Figure 43. Pressure Vessel Nozzle

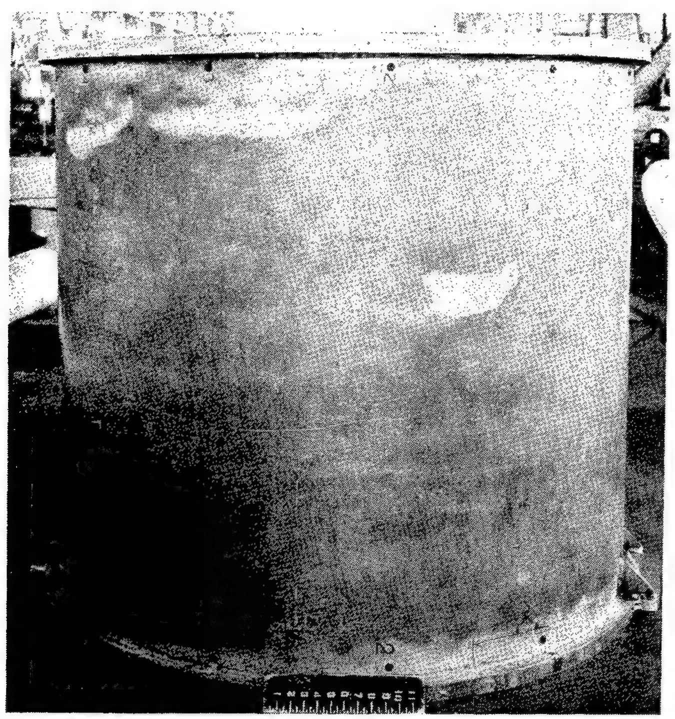


Figure 44. Pressure Vessel Center Section

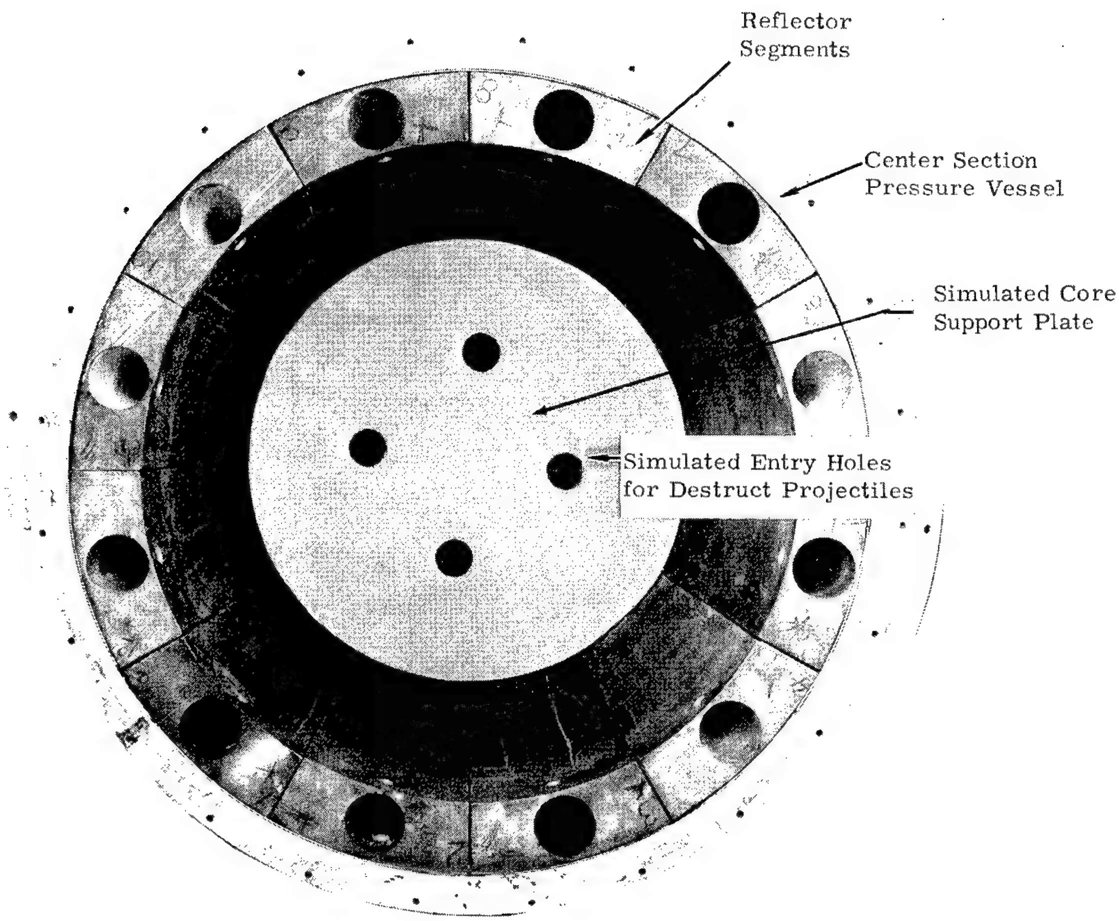


Figure 45. Partially Assembled Mockup Propulsion Engine

The completed assembly, except for the simulated nozzle, is illustrated in Figure 46. These are generalized pictures of components which omit any component classified by reason of shape or size. This generalization, however, does not reduce the effectiveness of the overall description of the space engine mockup.

The locations of the explosive charges used to destroy the mockup are indicated in Figure 46. The explosives as well as detonator system will be described in the next section.

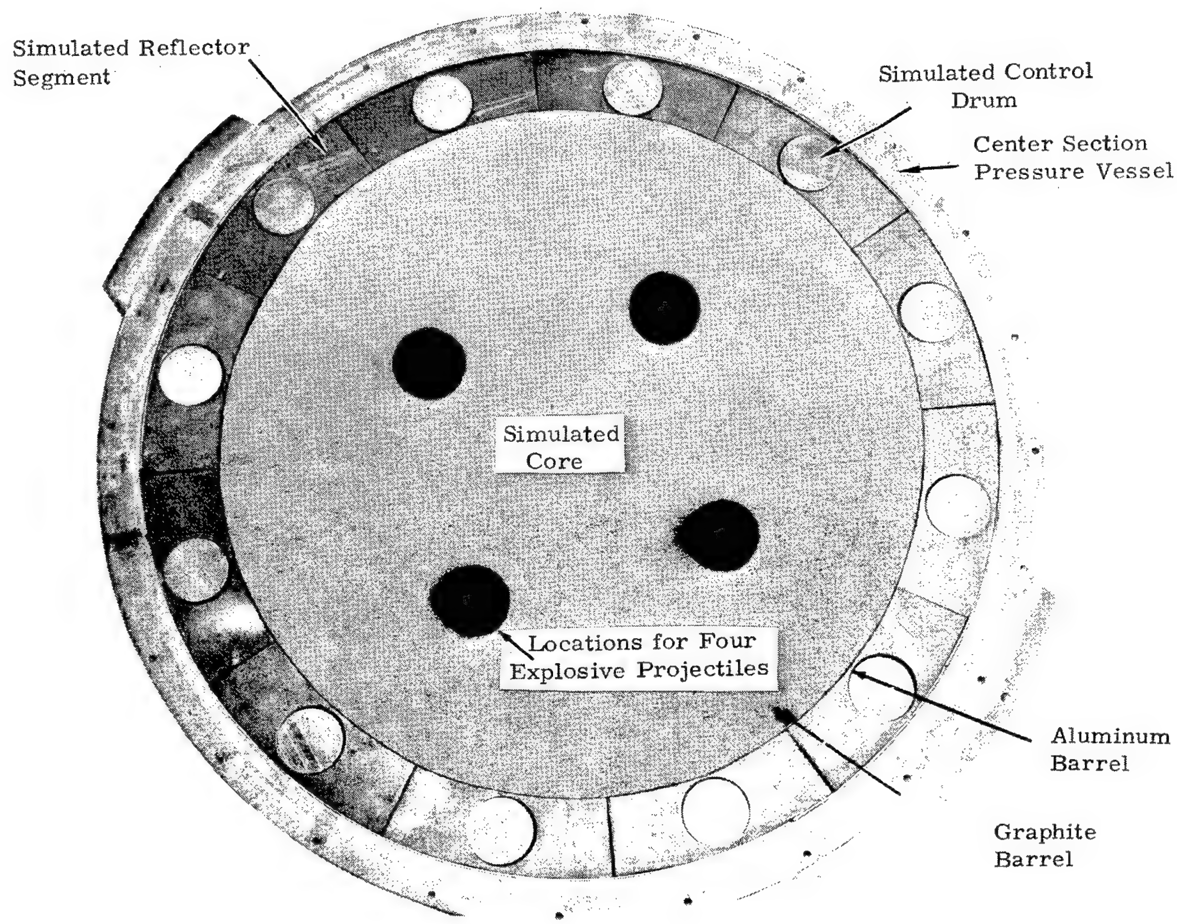


Figure 46. Assembled Mockup Propulsion Engine Less Nozzle

Description of Explosive Charges and the Detonator System

The mockup propulsion engine was destroyed by four special 105 mm projectiles manufactured and supplied by Picatinny Arsenal, Dover, New Jersey; In the normal situation, these projectiles (Figure 47) are launched into the propulsion engine, but in this test the projectiles were statically placed in the reactor core to allow a more highly-controlled destruct test.

Figure 48 shows an SE-1 detonator assembly with adapter used to initiate the explosive charge. The adapter holds the bridge wire and tetryl booster pellet firmly against the RDX booster in the special projectile. The projectiles were loaded with 94/6 percent DATB/polystyrene explosive and used PB-RDX boosters. The total explosive weight (four projectiles) was 111.17 pounds. Included in the total weight were 4.84 pounds of booster material.

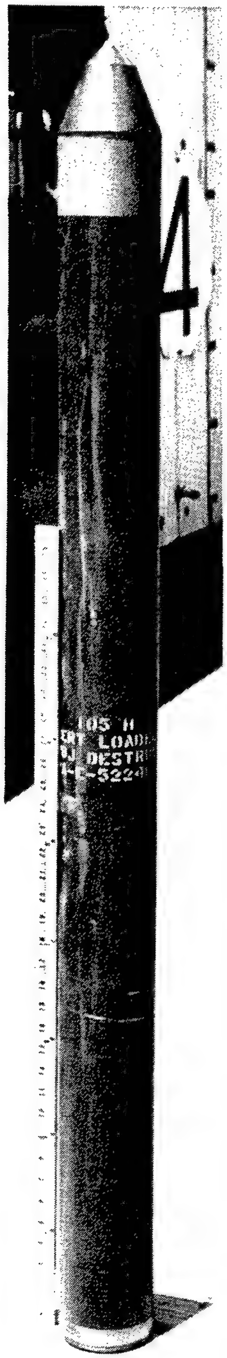


Figure 47. 105 mm Projectiles Used to Destroy the Mockr Propulsion Engine

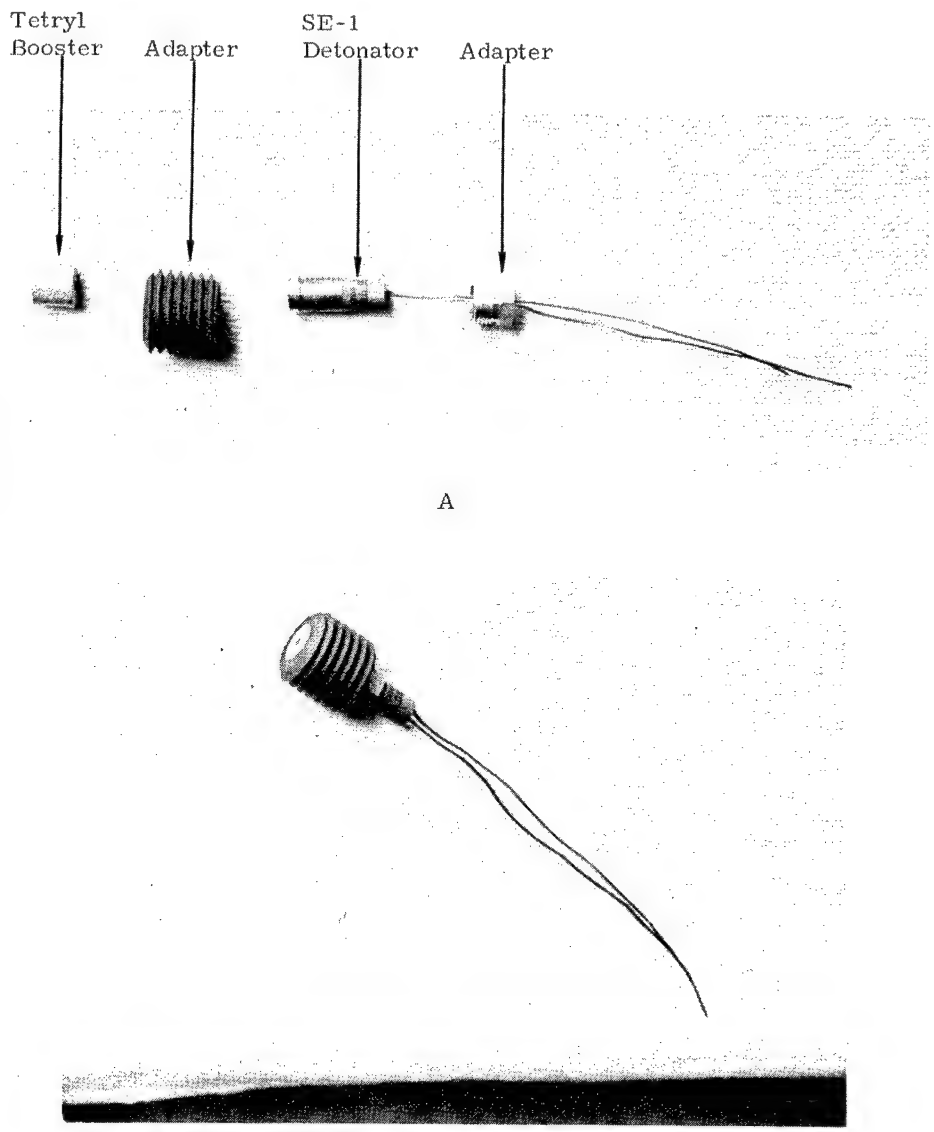


Figure 48. SE-1 Detonator Assembly with Adapter

The booster (PB-RDX) was initiated with two pellets of tetryl (1/2 inch diameter by 1/2 inch high cylinder) which were initiated by two exploding bridge wires. The bridge wires were given a high-energy pulse from a field test X-unit.

Although only four explosive charges were used to destroy the mockup propulsion engine, 12 detonators were used in the system. Each explosive charge was fitted with two detonators to give reliability and ensure simultaneous initiation of all four charges.

The remaining four detonators were placed on the external surface of the pressure vessel to allow streak camera coverage of the actual firing times for these detonators. Figure 41 shows the location for the detonators.

Arming and Firing System

Requirements

The arming and firing system must provide maximum safety and must provide precise time of firing as well as simultaneous firing of all detonators. The detonators shall be initiated and fired within 5 microseconds after firing pulse.

The equipment and procedures used to accomplish the above are described in the following paragraphs.

Firing System

The firing system was assembled from the following components:

- TC-2 high voltage supply
- FTXU - Field Test X-Unit
- Junction box
- Control panel
- Associated cables

The TC-2 high-voltage supply is a dual-voltage device, which receives a 28-volt input from nickel cadmium batteries and transforms the voltage to 2500 volts which are used to charge the capacitor of the FTXU. Interlock relays, set to close at 2400 volts, provide a 28-volt return signal which indicates full voltage available. Figure 49 shows the high-voltage supply.

The FTXU (Figure 49) is a single capacitor device with a dual trigger circuit; either channel will dump full voltage (2500 volts) through the 16 output connectors. The pulse through the 16 output connectors lasts 3-1/2 microseconds (positive phase) and has a rise time such that the total scatter in voltage application to all 16 output connectors does not exceed 60 nanoseconds (6×10^{-8} seconds).

The junction box (Figure 49) provides the termination for control cables, power supply, and X-unit. Further, the junction box is provided with a "keyed" shorting switch which positively prevents premature firing at the time of final detonator cable connection. Figure 50 shows a schematic diagram of the junction box circuit.

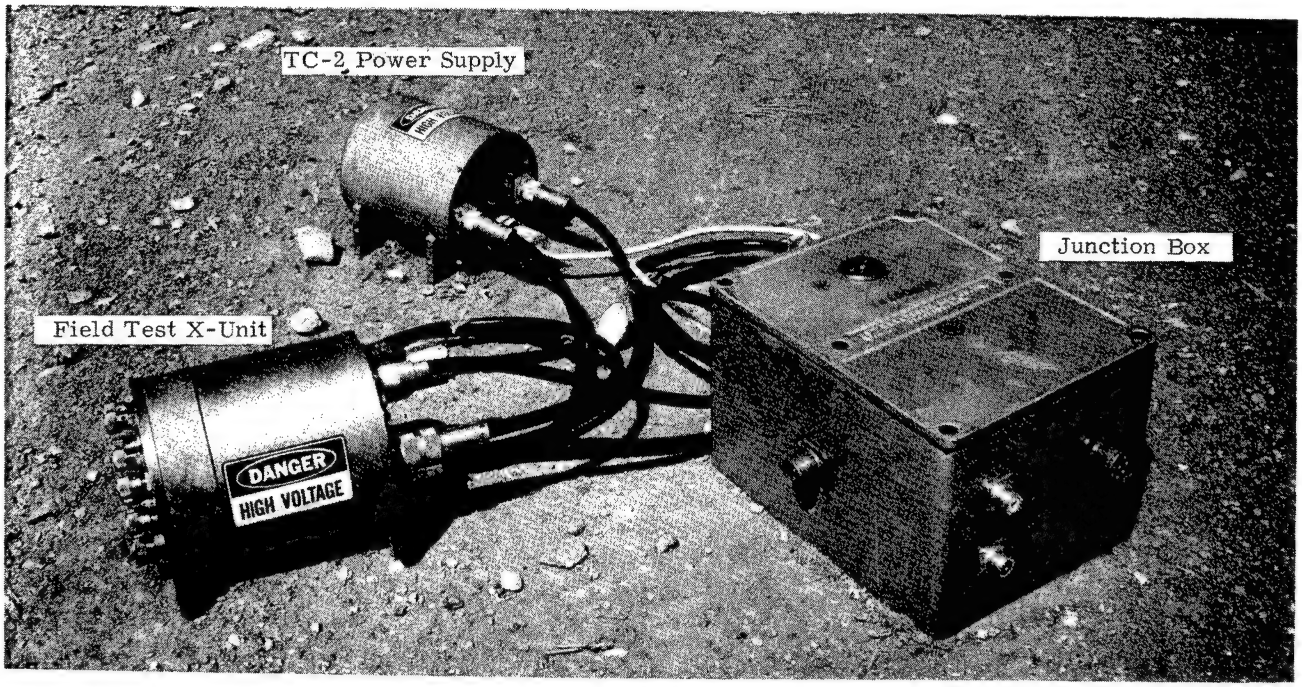


Figure 49. TC-2 Power Supply, Field Test X-Unit, and Junction Box

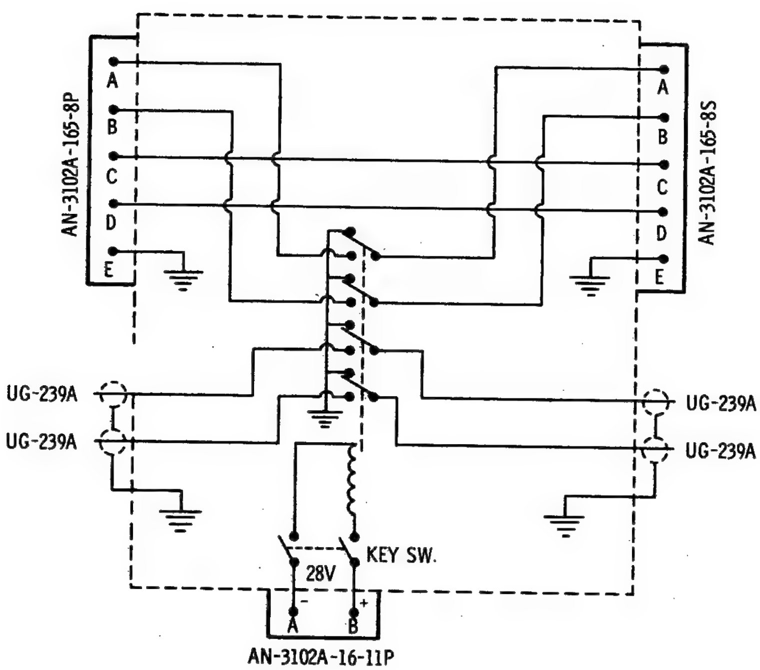


Figure 50. Junction Box Schematic

The control panel (Figure 39), located in the bombproof control center, was used to initiate charging and firing of the X-unit. This control panel was also provided with a "keyed" shorting switch which grounds all firing and charging circuits. Figure 51 shows a schematic of the control panel electrical circuit.

One key, which is in the possession of the Arming Officer at all times, provides access to both the junction box and the control panel. Figure 49 shows the firing system components interconnected.

The arming and firing system components in conjunction with the camera control countdown generator provide maximum safety and also ensure that cameras are started at the proper times to give coverage when the countdown generator provides a switch closure for firing the explosive charges. From minus 10 seconds on, all camera activities and firing are controlled by the countdown generator.

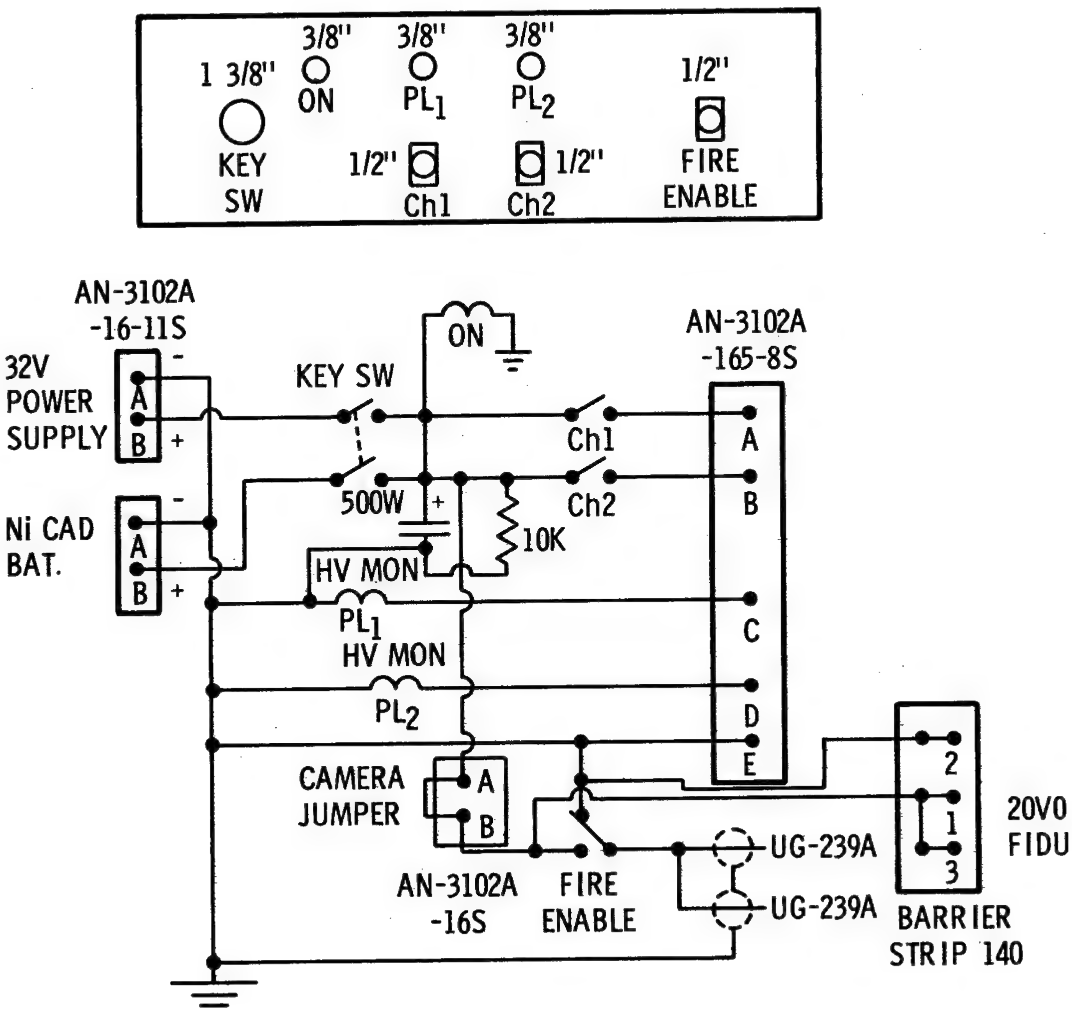


Figure 51. Control Panel Schematic

Safety Procedures

The following procedures were observed in order to provide maximum protection against accidental firing:

1. The arming and firing crew was never fewer than two people.
2. The single junction box and control panel "key" was in the possession of the Arming Officer at all times, and the switches on both control units were in the "shorted" position.
3. The atmospheric potential gradient was at all times below the 400 volts maximum.
4. The firing system and the detonators were approved high-energy devices, properly certified to be of high quality.

Arming and Firing Procedure

1. Prior to the final arming (connecting detonators to the X-units), the following checks were made:
   a. Control panel key switch "off" and key removed.
   b. Junction box key switch "off" and key removed.
   c. Shorting plugs in place on X-unit end of detonator cables.
   d. No voltage present at X-unit detonator cable connectors (checked with a VOM having 20,000 ohms per volt).
   e. All interconnector cables in place and firmly attached to the junction box, the TC-2 high voltage supply, and the X-unit.
2. Below is the arming procedure followed:
   a. The shorting plug was removed from a detonator cable. The cable and detonator were tested, with test set T-27, for a cable plus detonator resistance of 0.375 ± 0.005 ohms. (No other meter may be safely used.) Resistance values significantly varying from the above value would indicate a faulty detonator and/or cable. The cable was connected to the X-unit, by means of one of the outer ring connectors. The procedure was repeated for each cable in turn.
   b. Upon completion of Step a, the key was inserted to turn "on" the junction box. The key was removed. Operation of the relay inside the box was audible to the operator. This step removed the ground connection from the trigger cable and the TC-2 voltage supply cables and connected them to the main cables leading to the control panel.
   c. Arming was now complete, and the arming party returned to the control point.
3. The following fire enabling procedure was used:
   a. The key was inserted in the control panel key switch and turned "on". Amber pilot lamp indicated power on.
   b. The "fire enable" switch was in the down (off) position, and the safety cover was closed.

c. Safety covers were lifted, and the Charge 1 and Charge 2 switches on the control panel were turned to "on". After a short delay, the red pilot lamps over the switches indicated that the TC-2 power supply had charged the X-unit capacitor to within 100 volts of the final charge voltage.

d. When both Charge 1 and Charge 2 pilot lamps were properly lit, the unit was ready for firing. The "fire enable" switch was set to the "on" position about T-1 minute during the countdown.

4. The firing and the follow-up procedures are as follows:

a. The actual firing was accomplished by a switch closure in the camera control countdown generator. At the instant this switch closed, 28 volts were applied to both trigger cables leading to the X-unit and to other devices requiring a signal at zero time.

b. After the firing, the arming officer turned the control panel key switch to "off", removed the key, and proceeded to ground zero and inserted the key in the junction box key switch and turned it to "off".

Description of Countdown Procedure

The countdown was designed to preclude errors of omission and to give maximum confidence that data would be obtained and that all equipment would be operating satisfactorily at the time of test firing. The sequence of events in the following countdown list ensures the operation of all systems prior to test firing.

Communication check	T-4 hrs
Check generator gas and oil	
Start generator	
Check generator output	
Air sampling checkout and adjustment	
Camera adjustment, loading, and run	
Rotating devices timing check	
Rotating devices run check	
Pressure calibration check	
Clear area and establish road blocks	T-15 min
Head count of personnel and location of personnel	T-10
Timing tone	T-5 min
Timing tone	T-4 min
Timing tone	T-3 min
Timing tone	T-2 min
Timing tone	T-1 min
Firing enabling switch to "on" position	T-1 min

Start catcher motors	T-30 sec
Start catcher timing system	T-30 sec
Timing tone	T-10 sec
Countdown generator* switched on	T-10 sec
Air sampling start	T-10 sec
Pressure recorder run	T-10 sec
Helicopter cameras start	T-10 sec
Continuous timing count on all communication nets and timing tone	From T-10 sec to T-0 sec
Camera start (on timer)	
Mitchells	T-4 sec
Aerial cameras	T-4 sec
Fastax	T-800 to 1000 ms
Dynafax	T-50 ms
Fairchild	T-50 ms
Firing by countdown generator	T-0
High speed cameras stop	T+10 sec
Catcher motors stop	T+30 sec
Catcher timing system stop	T+30 sec
Pressure recorder stop	T+30 sec
Air sampling stop	T+2 min
Other camera stop	T+2 min
Explosive safety and radiation safety area check	T+5 min
Start debris analyses	T+15 min

The countdown list shows the interrelation of the instrumentation system and the firing system, and thus complements the earlier description of the firing procedure.

Data Collection

To preclude any possibility of personnel injury and to ensure that a maximum amount of data are collected, the following re-entry plan was established and followed.

1. Radiation safety and explosive safety teams declared the area safe to enter.

*The countdown generator provides timed sequencing for all instrumentation camera starts and a switch closure for test firing.

2. To avoid contamination by foreign materials, battery fallout jars were covered.
3. While battery jars were being covered, the instrumentation photographers removed film, and the documentary cameramen photographed the debris.
4. The battery jars were removed from the southwest quadrant to allow the removal of Sandia Corporation collection equipment.
5. The trucks and crane were moved into the southwest quadrant, and recovery operations began on the rotating foam plastic velocity devices and fixed foam particle collectors.
6. Concurrent with Step 5 above was the continued collection of battery jars, the collection of debris from the hard surface pad, and the removal of the Sandia air sampling equipment.
7. The pressure recording equipment was removed.

Test Results

All systems installed for data collection were operative and did collect data, with the exception of the camera hand-held in the helicopter.

Each subsystem which either collected data or was associated with data collection will be discussed in order of occurrence or in order of the completion of data reduction.

Firing Countdown

This procedure will be discussed because an approximate 8-second delay occurred between the verbal countdown, used by the airborne and documentary photographers, and the electronic countdown which triggered all instrumentation cameras and the explosive charge.

This delay was caused by high noise conditions; the man starting the electronic countdown generator did not hear the verbal countdown being transmitted by radio, which signaled the T-10 second time. This error was in no way detrimental to instrumentation photography but did cause some loss of helicopter and documentary photography.

Aberdeen Proving Ground was successful in obtaining photographic coverage from helicopters. Slower speed cameras were used, thereby providing film coverage of the explosive destruct debris pattern.

Blast Pressures and Photo Resistive Unit

The 12 pressure transducers used during the test produced 11 channels of useable information. The pressures were:

Distance from Ground Zero	In Jet	45° from Jet	$\pm 5^{\circ}$ Beside Jet	
			-5°	$+5^{\circ}$
20 feet	23.0	22.5	23.0	22.8
30 feet	8.0	7.5	7.95	7.96
40 feet	4.2	4.1	4.2	No reading

All pressure transducers, which were recalibrated after the test, verified that no damage was sustained during the test.

The Photo Resistive Unit response time was too slow to obtain results. The time from detonator fire to case rupture was not measured. Although the calculation of overpressure wave velocity was desired, the lack of zero time mark expected from the photo resistive unit made the determination impossible.

Glass Rod Velocity Data

Glass rods were positioned in four areas to determine the velocity of the dome, nozzle, west jet, and south jet. Due to the RF interference experienced, the average velocities obtained from the glass rod instrumentation data are considered to have a tolerance of ±5 percent. The data obtained at each of these locations follows.

Dome and Nozzle -- Four glass rods were located at various distances from both the nozzle and the dome to provide velocity data. Because of the RF interference generated by the explosion, the average velocity of the dome over its first 3-inch displacement and the nozzle over its first 2.25-inch displacement were the only velocities obtained from the glass rod data.

The data indicated an average velocity of 590 fps for the nozzle and 67.5 fps for the dome over the given distances.

West Jet -- Positioned along the path of the west jet were eight glass rods: seven for velocity measurement and one for detection of case breakup. Data were obtained from seven of the eight positions.

The average velocities measured from ground zero to the distances indicated are given below.

Distance (ft)	Average Velocity (fps)
10	No data
20	570
30	420
40	550
50	507
60	490
70	465

Using the data from the glass rods, a plot of the displacement of the leading edge of the west jet versus time was made as shown in Figure 52. By calculating the slope of this curve at several points, the velocity versus time curve was plotted.(Figure 53). This curve shows a linear decrease in velocity over the distance from 20 to 70 feet. Since the velocity versus time curve is linear, the deceleration was constant over the interval of time considered (Figure 54).

The time delay from detonation to case breakup along the west jet was recorded as 0.88 millisecond.

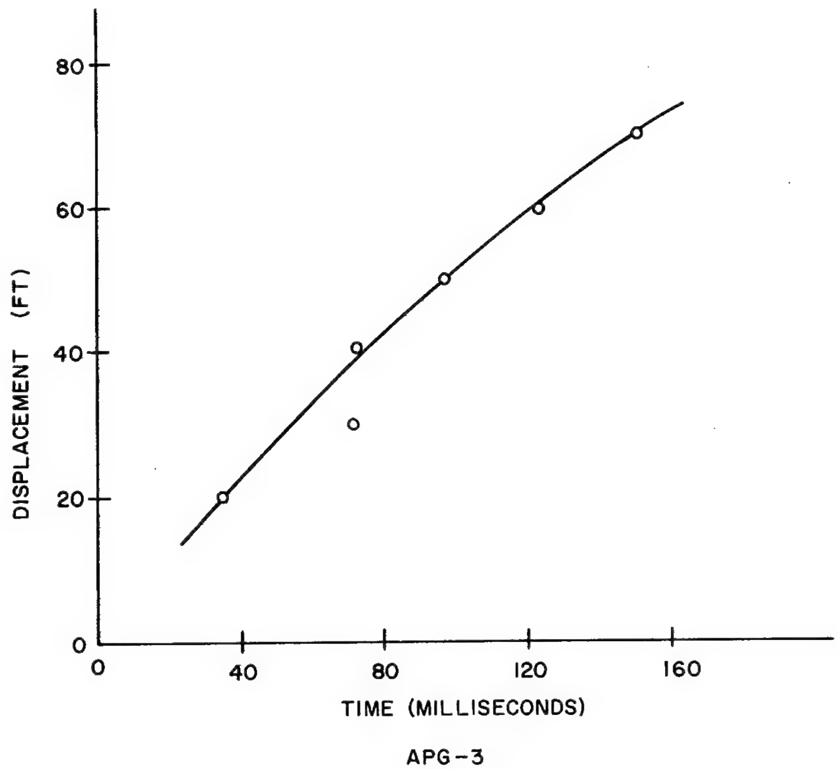


Figure 52. Displacement of Leading Edge of the West Jet versus Time

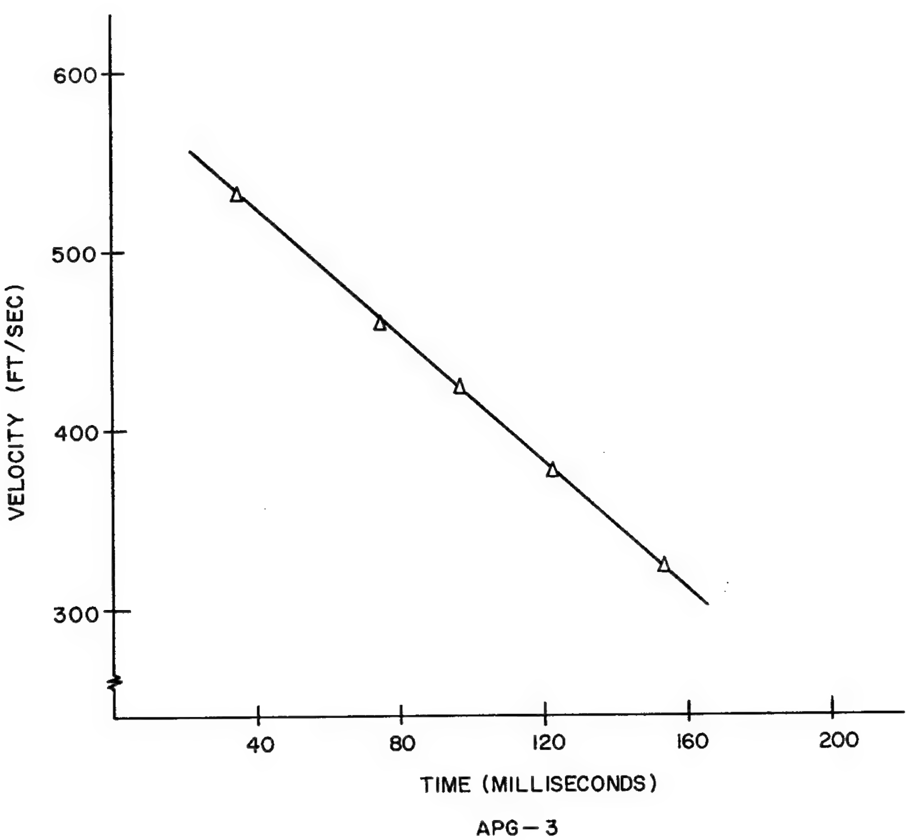


Figure 53. Velocity versus Time

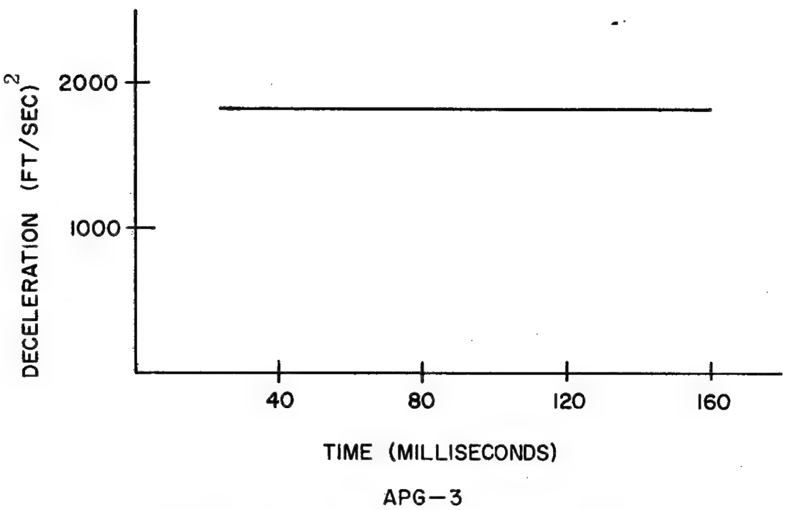


Figure 54. Deceleration versus Time

South Jet -- Four rods were positioned along the south jet--three for velocity measurement and one to indicate case breakup. Data were obtained from two of the four locations.

Only one velocity measurement of the three planned was recorded. An average velocity of 570 fps was recorded (over a distance of 30 feet from ground zero).

The time delay from detonation to case breakup along the south jet was recorded as 1.6 milliseconds.

Rotating Polystyrene Foam Velocity Devices

These velocity devices successfully obtained the average velocity of particles as a function of particle volume, mass, and shape. Photographs of the particles collected are contained in Appendix B. These photographs show the particle size and shape and are labeled as to their mass and magnification.

Thirty rotating devices were mounted at the test location. Nine rotating devices were destroyed during the test: four rotating drums, two rotating twin discs, and three rotating single discs. This loss is as expected; therefore, these units will not be considered when the percent data recovery is calculated. From the remaining twenty-one units, data were obtained from four rotating single discs, four rotating twin discs, and three rotating drums; data recovery was about 52 percent. Figures 55 through 58 show typical debris impact on single disc, twin disc, and drum velocity devices.

The data from the rotating foam velocity devices are tabulated on pages 57 and 58. The tabulation shows the relationship of velocity as a function of distance, particle mass (size), and the numbers of the photographs which illustrate particle shape.

Using a combination of velocity devices located at the same distance from ground zero gives an indication of the initial velocity.

Distance (ft)	Average Velocity (fps)	Final Velocity (fps)	Initial Velocity (fps)
32.25	472	173	771
52.18	449	184	714

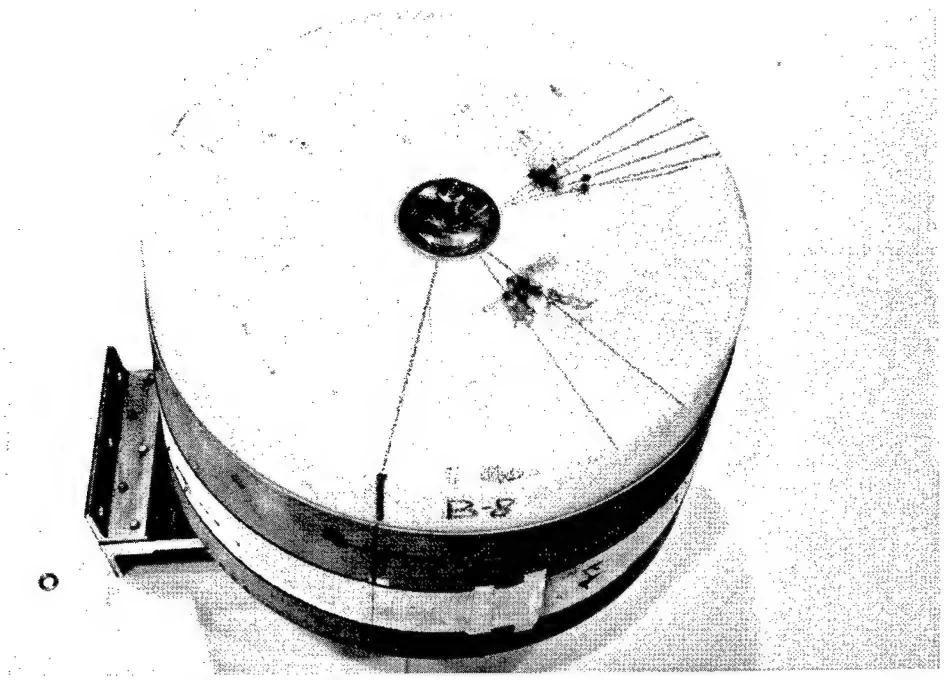


Figure 55. Single Disc Debris

Figure 56. Twin Disc - Front Collector Surface

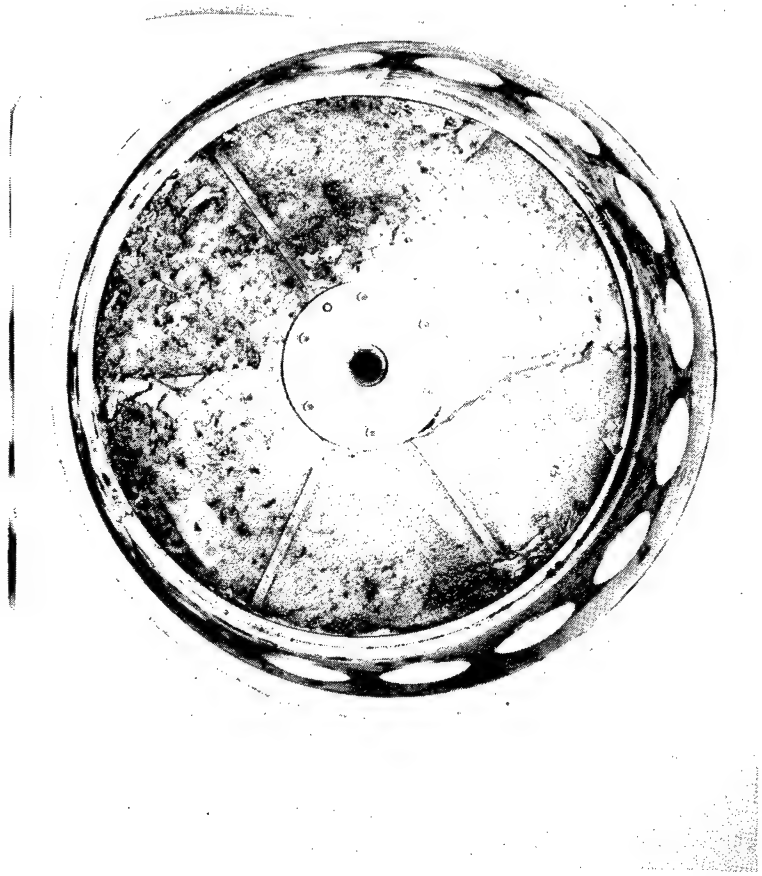


Figure 57. Twin Disc - Back Surface (Front Collector Removed)

Figure 58. Drum Debris

Velocity and Particle Data from Rotating Foam Velocity Devices

(1) Type Unit	(2) Distance (ft)	(3) Average Velocity (fps)	(4) Final Velocity (fps)	(5) Particle Mass (grams)	(6) Particle Volume (in^3)	(7) Particle Penetration (in.)	(8) Penetration Angle (degrees)	(9) Photo* of Particles (No.)	(10) Remarks
Single disc	72.7	404		0.1169	0.0043	0.19		1	
		408		0.1135	0.0038	0.56	56.3	2	
		411		0.0114	0.00024	0.06		3	
		420		0.0640	0.0027	0.44	70.4	4	
		420		0.1965	0.0064	0.44	70.4		
Single disc	72.7	310		0.0252	0.0011	0.12	29.8	5	
		321		0.0035	0.0002	Surface		6	
		340		0.0158	0.0008	Surface		7	
		343		0.0166	0.0008	0.22		8	
		344		0.0322	0.0014	0.22		9	
		363		0.2946	0.0268	0.81	69		
		407		0.6316	Broken by Impact	0.87	36.4	10	
Single disc	52.2	450		0.0629	0.0027	Surface		11	
		452		0.0289	0.0014	0.22		12	
		457		0.0873	0.0032	Surface		13	
		479		0.1482	Broken by Impact	Surface		14	
		484		Lost					
Single disc	38.2	523		0.1687	0.0060	0.19	23.2	15	
		550		0.0108	0.0005	Surface		16	
Twin disc	72.7	395							Impact so heavy that analysis of individual particles was not possible.
		413							
Twin disc	52.2		184	0.0087	0.0004	Surface			No zero time mark visible and therefore average velocity could not be determined.
				0.0327	0.0015	0.19	28.6		
				0.0083	0.0004	0.16	29.1		
				0.0046	0.0001	0.16	29.1		
				0.0731	0.0026	Surface			
				0.0032	0.0001	Surface			
				0.0130	0.0005	0.06			
				0.0022	0.0001	Surface			
				0.0230	0.0009	0.16			
Twin disc	38.4	525							Particle lost.

*The photographs reflected by these numbers are shown in Appendix B.

Velocity and Particle Data from Rotating Foam Velocity Devices (cont)

(1) Type Unit	(2) Distance (ft)	(3) Average Velocity (fps)	(4) Final Velocity (fps)	(5) Particle Mass (grams)	(6) Particle Volume (in^3)	(7) Particle Penetration (in.)	(8) Penetration Angle (degrees)	(9) Photo of Particles (No.)	(10) Remarks
Twin disc	32.2		173	0.0146	0.0005	Surface			No zero time mark visible and therefore average velocity could not be determined.
				0.0197	0.0009	Surface			
				0.0526	0.0039	Surface			
				0.0484	0.0018	0.19	16.7		
				0.0111	0.0003	0.06			
				0.0096	0.0004	Surface			
Drum	72.7	347		0.181	0.0055	Surface		17	
		362		0.189	0.0069	Surface		18	
		365		0.044	0.0011	Surface		19	
		369		0.098	0.0033	Surface		20	
		441		3.256	0.2051	0.62	46.5†	21	
		444		0.720	0.0714	Surface		22	
		445		3.071	0.2242	Surface		23	
Drum	38.4	382		0.0188	0.0004	0.28	52.1†	24	
Drum	32.2	422		0.0348	0.0015	Surface		25	
		422		0.0113	0.0011	Surface			
		430		0.0468	0.0032	0.22		26	
		468		1.0648	0.0923	0.75	63.4†	27	
		472		0.9307	0.0782	1.31	51.0†	28	

†Angles are measured from a plane tangent to the surface of the drum.

Fixed Polystyrene Foam Particle Collectors

These foam blocks fulfilled two of the three purposes previously described. Graphite core debris was collected, and the energy from impacting metal parts was absorbed, but the destructive force of the blast pressure scattered the foam such that relative concentration of debris data was not obtained.

The graphite core debris collected was a representative sample although the quantity was small. The total weight of the sample collected was 14,424.308 grams (31.8 pounds) -- 8706.246 grams (19.2 pounds) of core material and 5718.062 grams (12.6 pounds) of graphite reflector material. More graphite reflector material is contained in the core material sample, but only the top four size ranges allowed physical separation. The graphite reflector sample represents 2.1 percent of the total; the core material sample represents 0.75 percent of the total core material.

These graphite debris samples were removed from the polystyrene foam by dissolving the foam in a solvent and then separating the graphite from the liquid by filtering it through a 400 mesh Tyler screen (opening 37 microns). Those particles which were collected in the 400 mesh screen were then sorted according to size by passing them through standard sieves in a Ro-Tap shaker which agitated the debris for 2 minutes. The data obtained (Table I) includes the screen size, the weight of material on each screen, the weight percent of the total material collected on each screen, and the accumulated weight percent starting from the smallest screen size. These data are plotted on Figures 59, 60, and 61.

The uranium content is necessary for safety analyses. Two techniques provided data on the quantity of uranium present in each size range of collected graphite debris. Table II tabulates the results of shielded gamma counting of a small sample of graphite from each size range. The gamma counting was done on a multichannel analyzer and indicates a trace of uranium between 53 and 74 microns with essentially no indication of uranium below 53 microns. See Appendix F for the raw counting data. The data tabulated in Table II is plotted on Figures 59, 60, and 62.

The same sample of graphite debris that was gamma counted to determine the uranium content was also subjected to chemical analysis to determine the uranium content. The data from the fluorimetric chemical analysis is tabulated in Table III and plotted on Figures 59, 60, and 62.

The two techniques for determining uranium content agree well. Therefore the data are thought to indicate accurately the uranium to be expected in each size range of graphite debris.

A representative sample of the particles collected in the fixed polystyrene foam was photographed to provide information about the size and shape of the particles in each size category. The photographs of the particles are contained in Appendix C where each photograph is identified as to the size of particle and the magnification used for photography.

Air Sampling

On the day of firing, the impingers were filled with filtered collection solution, and their flow rates were adjusted to draw 2.8 liters per minute. At the time of firing, an 8 to 12 mph wind was blowing across the ground zero area from a SSE direction. This wind velocity was at the upper limit of acceptability for atmospheric sampling but did not prohibit the test.

TABLE I

Graphite Debris Sorted as to Size, Weight Percent in Each Size and Accumulated Weight Percent

Screen Size (mm)	Weight (grams)	Weight (%)	Accumulated Weight (%)
26.9	48.778	0.56	100.0
19.0	378.750	4.3	99.4
13.5	618.708	7.2	95.1
9.51	673.144	7.7	87.9
6.73	891.650	10.2	80.2
4.76	1004.104	11.5	70.0
3.36	1859.359	21.3	58.5
2.38	1008.914	11.6	37.2
1.41	616.708	7.1	25.6
1.00	222.906	2.6	18.5
0.841	95.649	1.2	15.9
0.595	145.497	1.7	14.7
0.420	191.141	2.2	13.0
0.354	64.388	0.7	10.8
0.210	183.533	2.2	10.1
0.149	126.619	1.4	7.9
0.105	92.128	1.0	6.5
0.074	59.101	0.7	5.5
0.053	29.730	0.3	4.8
0.037	63.673	0.7	4.5
Filter Paper	331.766	3.8	3.8

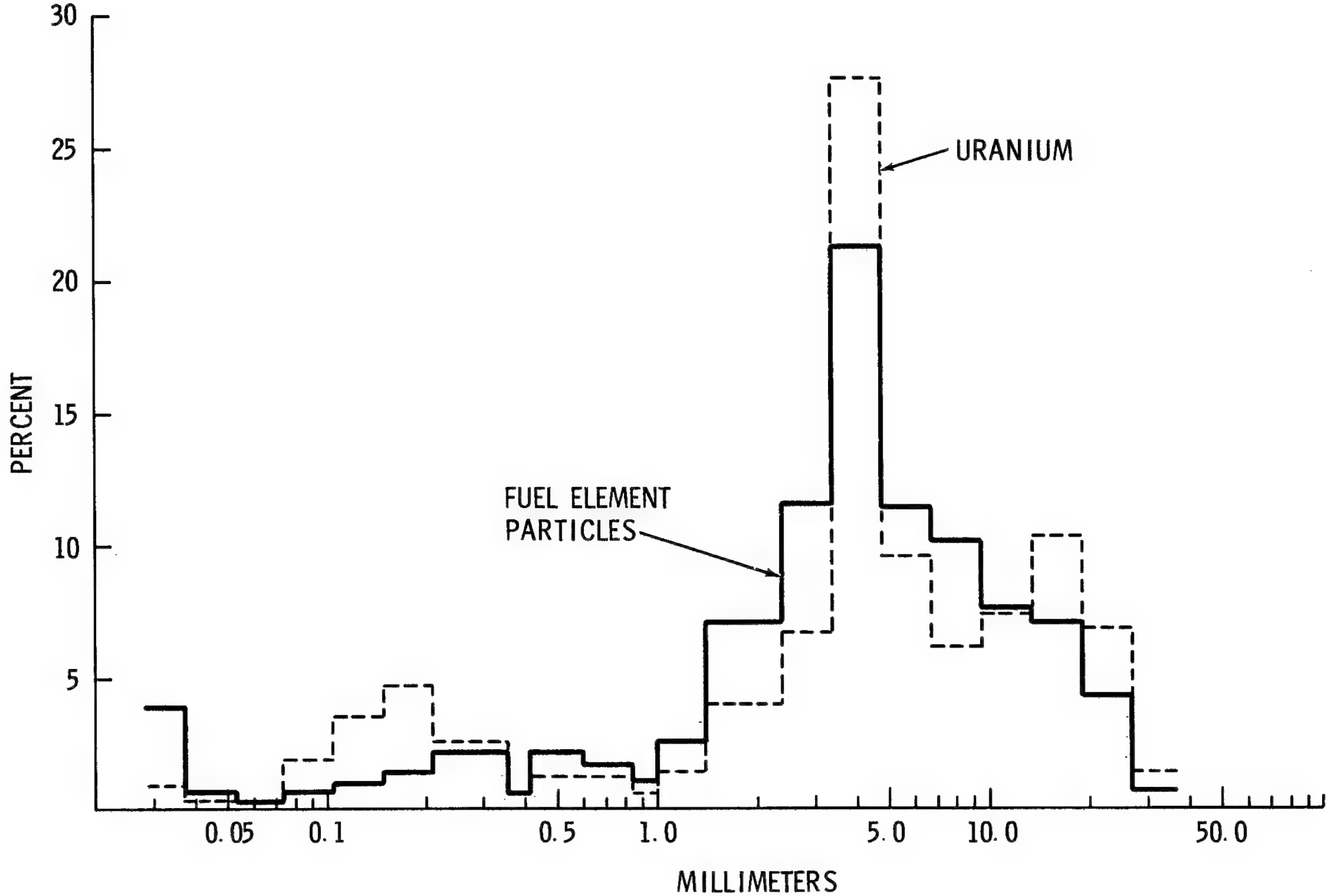


Figure 59. ROVER/NERVA Full-Scale Destruct Particle Size versus Weight Percent

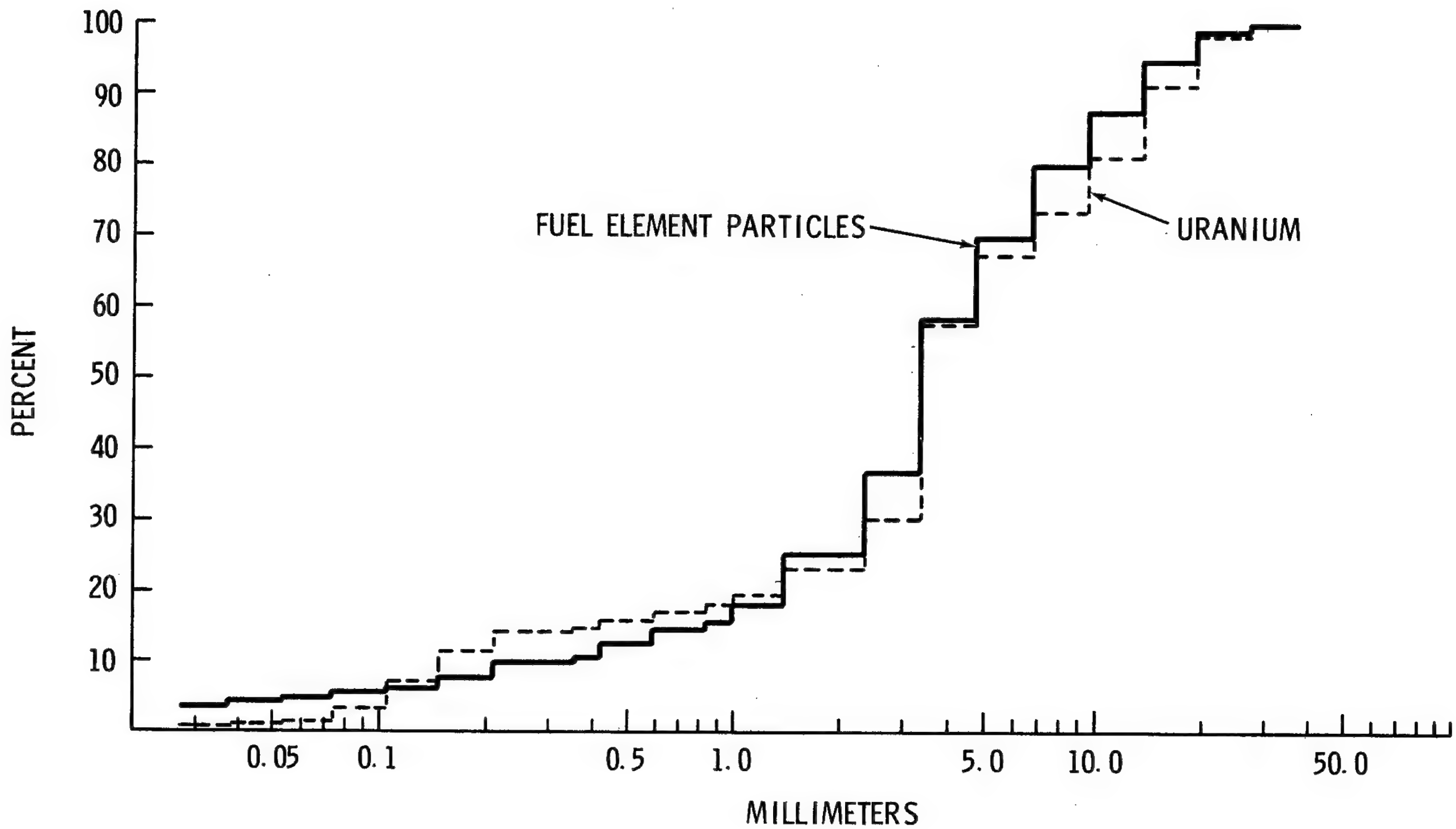


Figure 60. ROVER/NERVA Full-Scale Destruct Particle Size versus Accumulated Weight Percent

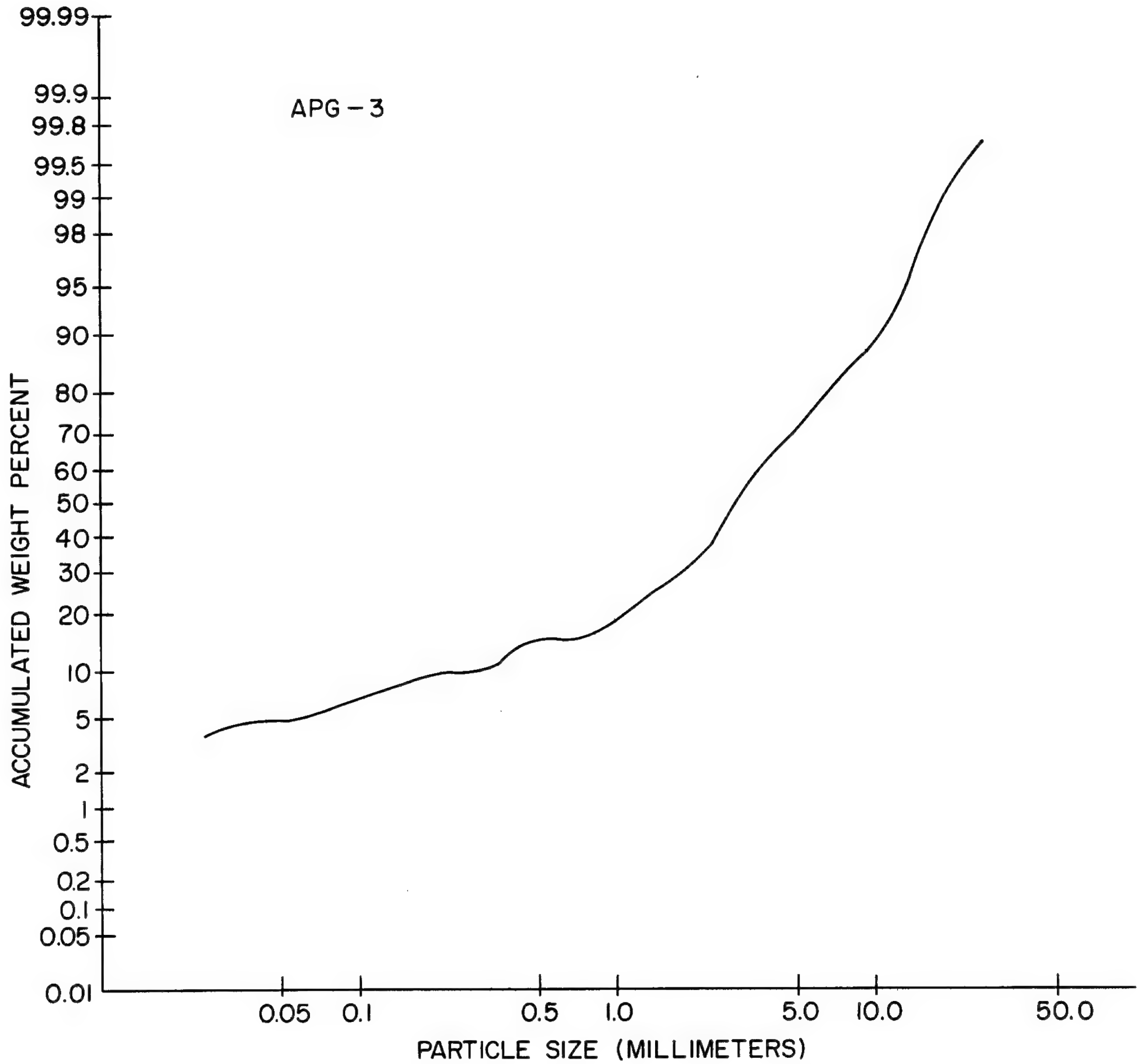


Figure 61. Log-Probability Curve for Graphite Debris

TABLE II

Shielded Gamma Counting Data Performed on a Multichannel Analyzer

(1) Run No.	(2) Gamma Counts	(3) Gamma Counts Peak Count	(4) Gamma Counts	(5) $\left(\frac{2+3+4}{3}\right)$ Average Count	(6) Multiply Average by	(7) (5 x 6) Count for 60 min.	(8) Background Gamma Count	(9) (7 - 8) Average Gamma Count from Sample	(10) Wt of Sample Counted Grams	(11) $\left(\frac{9}{10}\right)$ Counts per Gram	(12) Weight Sample each Screen	(13) (11 - 12) Counts per Sample	(14) Wt Percent based on Gamma Counts	(15) Accumulated Wt Percent based on Gamma Counts	(16) Screen Size (mm)
1	601	651	633	628	3	1884	118	1766	5.536	319.0	48.778	15560.1	00.7	100.69	26.9
	530	619	589	579	3	1737	76	1661	5.536	300.0	48.778	14633.4	00.7	105.69	
2	546	597	576	573	3	1719	115	1604	4.760	336.0	378.750	127260.0	06.0	99.99	19.0
	525	570	563	553	3	1659	74	1585	4.760	332.0	378.750	125745.0	06.0	104.99	
3	713	777	730	740	3	2220	115	2105	6.965	302.0	618.708	186849.8	09.0	93.99	13.5
	758	789	777	775	3	2325	73	2152	6.965	308.0	618.708	190562.1	09.5	98.99	
4	670	777	720	722	2	1444	118	1326	5.355	247.0	673.144	166266.6	08.0	84.99	9.51
	750	762	610	707	2	1414	72	1342	5.355	250.0	673.144	168286.0	08.4	89.49	
5	697	707	674	693	2	1386	119	1267	8.564	147.0	891.650	131072.5	06.2	76.99	6.73
	692	696	634	674	2	1348	76	1272	8.564	148.0	891.650	131964.2	06.6	81.09	
7	1102	1164	1147	1138	2	2276	120	2156	8.808	244.0	1004.104	245001.4	12.0	70.79	4.76
	1148	1220	1043	1137	2	2274	76	2198	8.808	249.0	1004.104	250021.9	12.5	74.49	
6	1063	1136	1102	1100	2	2200	119	2081	7.850	265.0	1859.359	492730.1	23.3	58.79	3.36
	1077	1096	1071	1081	2	2162	78	2084	7.850	265.0	1859.359	492730.1	24.6	62.99	
8	930	993	962	962	2	1924	119	1805	6.640	271.0	1008.914	273415.7	13.0	35.49	2.38
	944	1009	978	977	2	1954	78	1876	6.640	282.0	1008.914	284513.7	14.2	38.39	
9	965	995	951	970	2	1940	119	1821	7.360	247.4	616.708	152573.5	07.2	22.49	1.41
	970	991	954	972	2	1944	78	1866	7.360	253.0	616.708	156027.1	07.8	24.19	
11	658	689	635	661	2	1322	118	1204	5.148	233.0	222.906	51937.1	02.5	15.29	1.00
	653	736	666	685	2	1370	76	1294	5.148	251.0	222.906	55949.1	02.8	16.39	
12	598	622	588	603	2	1206	119	1087	4.841	224.0	95.649	21425.4	01.0	12.79	0.841
	594	617	557	589	2	1178	76	1102	4.841	227.0	95.649	21712.3	01.1	13.59	
10	455	460	445	453	2	906	118	788	3.913	201.0	145.497	29244.9	01.4	11.79	0.595
	471	491	467	476	2	952	78	874	3.913	223.0	145.497	32445.8	01.6	12.49	
14	552	559	486	532	2	1064	118	946	5.541	170.0	191.141	32493.9	01.5	10.39	0.420
	529	543	445	506	2	1012	76	936	5.541	168.0	191.141	32111.7	01.6	10.89	
13	368	413	396	392	2	784	120	664	3.981	166.0	64.388	10688.4	00.5	08.89	0.354
	334	364	348	349	2	698	76	622	3.981	156.0	64.388	10044.5	00.5	09.29	
15	585	608	592	595	2	1190	119	1071	4.412	242.0	183.533	44414.9	02.0	08.39	0.210
	584	613	590	596	2	1192	78	1114	4.412	252.0	183.533	46250.3	02.3	08.79	
16	1386	1526	1525	1479	2	2958	120	2838	5.673	500.0	126.619	63309.5	03.0	06.39	0.149
	1288	1525	1469	1427	2	2854	80	2774	5.673	488.9	126.619	61904.0	03.0	06.49	
17	1248	1331	1219	1266	2	2532	119	2413	4.193	575.0	92.128	52973.6	02.5	03.39	0.105
	1220	1297	1198	1238	2	2476	78	2398	4.193	571.0	92.128	52605.1	02.6	03.49	
18	388	470	453	437	2	874	119	755	3.233	233.0	59.101	13770.5	00.7	00.89	0.074
	433	478	432	448	2	896	76	820	3.233	253.0	59.101	14952.6	00.7	00.89	
19	313	338	324	325	1	325	120	205	3.017	67.0	29.730	1991.9	00.09	00.19	0.053
	287	300	288	292	1	292	78	214	3.017	70.0	29.730	2081.1	00.1	00.19	
20	184	214	188	195	1	195	120	75	3.002	24.0	63.673	1528.2	00.07	00.10	0.037
	150	183	160	164	1	164	82	82	3.002	27.0	63.673	1719.2	00.09	00.09	
21	120	135	105	120	1	120	119	1	0.513	1.92	331.766	636.99	00.03	00.03	Less than
	87	89	80	85	1	85	86	0	0.513	0	331.766	0	0	0	0.037

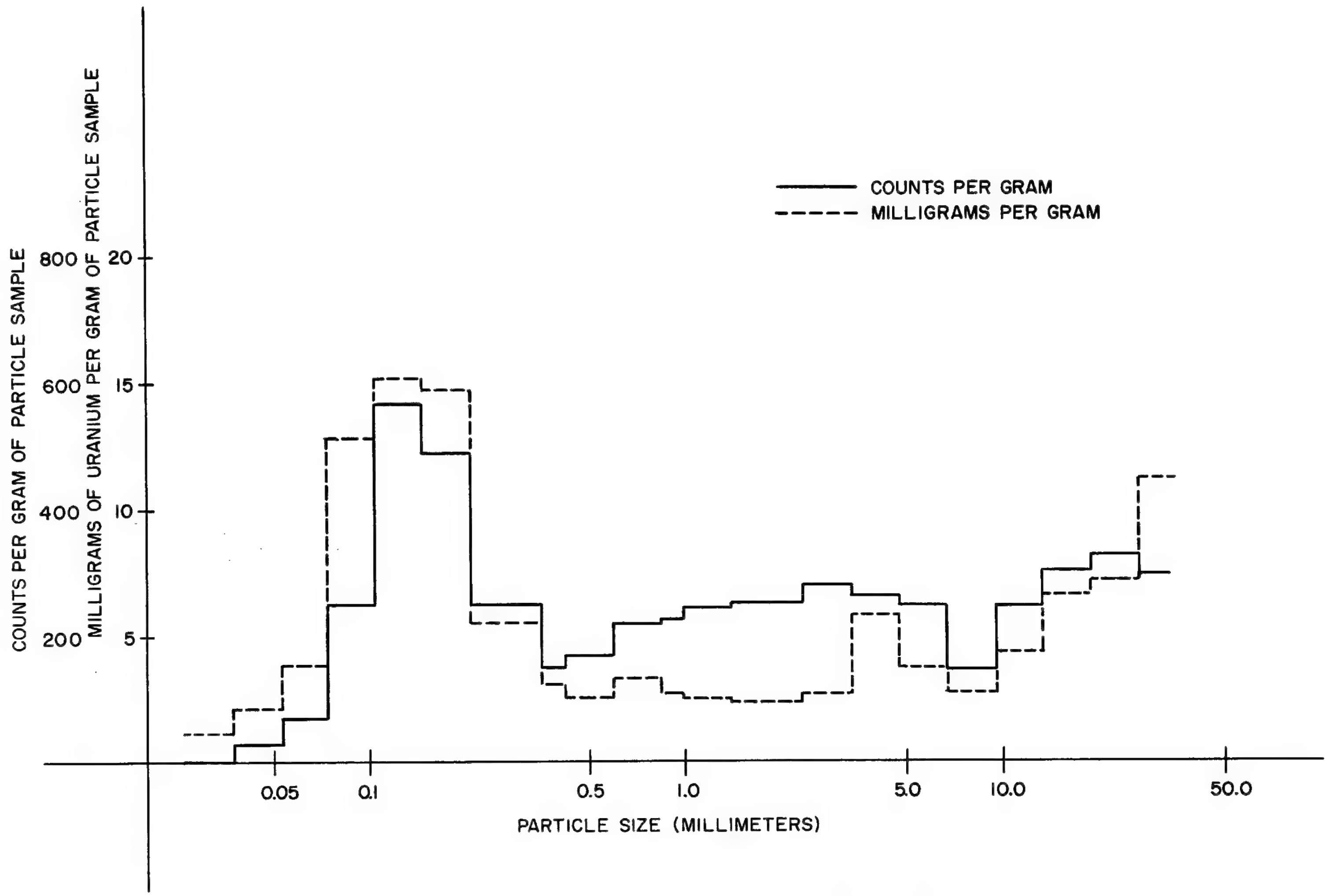


Figure 62. Uranium Content Observed in Graphite Debris

TABLE III

Uranium Content Determined by Fluorimetric Analysis

Size (mm)	Mg Uranium/gr Sample	Total Grams Collected	Total Mg Uranium	Weight (%)	Accumulated Weight (%)
Less than 0.037	1.07	331.77	354.99	0.90	0.9
0.037	2.14	63.67	136.25	0.34	1.24
0.053	3.98	29.73	118.33	0.30	1.54
0.074	12.98	59.10	767.12	1.94	3.48
0.105	15.26	92.13	1,405.90	3.55	7.03
0.149	14.90	126.62	1,886.64	4.76	11.79
0.210	5.54	183.53	1,016.76	2.57	14.36
0.354	3.14	64.39	202.18	0.51	14.87
0.420	2.62	191.14	500.79	1.26	16.13
0.595	3.44	145.50	500.52	1.26	17.39
0.841	2.78	95.65	265.91	0.67	18.06
1.00	2.62	222.91	584.02	1.47	19.53
1.41	2.58	616.71	1,591.11	4.02	23.55
2.38	2.64	1008.91	2,663.52	6.72	30.27
3.36	5.90	1859.36	10,970.22	27.70	57.97
4.76	3.78	1004.10	3,795.50	9.58	67.55
6.73	2.75	891.65	2,452.04	6.19	73.74
9.51	4.40	673.14	2,961.82	7.48	81.22
13.5	6.66	618.71	4,120.61	10.41	91.63
19.0	7.26	378.75	2,749.72	6.94	98.57
26.9	11.44	48.78	558.04	1.41	99.98
			39,601.99		

The sample was collected for a 37.5-second period, during which time the cloud was observed to expand to about 125 feet in radius. It was then carried by the wind in a northerly direction. Sample collectors on the north side were enveloped in the cloud for the full 37.5 seconds, but the samplers in the other quadrants sampled the cloud for a proportionally shorter time. The period of time each sampler was exposed to the cloud and the measurement of the size of the cloud as it developed around the samplers will be calculated from the motion picture film made at the time from two different angles.

Air sampling of the airborne graphite cloud gave particles as follows: (1) Nearly 80 percent of the particles were in a size range of 0.5 to 3.5 microns, (2) 19 percent were in the range of 3.5 to 10 microns, and (3) 1 percent were in the range of 10 to 20 microns. The sampling instruments were designed to collect particles in the respirable size range and were not efficient for collecting particles larger than 20 microns. Therefore, the scarcity of larger particles does not imply that there were no airborne particles larger than that size.

Electron micro-photographs (Figure 63) showed the particles to be very irregular in shape which precludes application of an ideal size-weight relationship. Difficulty was also experienced in determining the volume of the aerosol cloud. The 5 jet pattern formed from the disintegration of the pressure vessel produced a cloud which had arms that extended beyond the sample array. Because of these variables, a weight-percent value which represents the amount of the core material in the aerosol was not made.

The uranium which was embedded in the core material was not found in the very fine particles of the atmospheric samples. It was calculated (by using the minimum levels of detectability for the analytical methods for determining uranium and the volume of the cloud which was sampled) that the concentration of airborne uranium was less than 0.0280 mg of uranium per cubic meter. This level is at most 10 percent of the maximum acceptable level for an industrial exposure to this material.

Details about the methods of analysis and a further description of the results of this test are discussed in the report "Evaluation of Microscopic-Sized Graphite Aerosol from a Rover Reactor Destruction Test," D. R. Parker, SC-RR-65-557.

Optical Velocity Data

The velocity and distribution of the mockup engine parts were recorded on photographic film. The cameras were generally located 90 degrees apart to provide trajectory information on each component from two quadrants and thus established the direction of flight. (Those objects which impacted the support posts or the Sandia velocity measuring stands were not tracked as these velocities would not provide a realistic picture of the debris velocity or distribution.) The photographic films had millisecond timing marks on the edges to provide time and distance. After analyzing the film, the data obtained along with camera location data were put into a computer, and the trajectories were calculated for those objects which were identified.

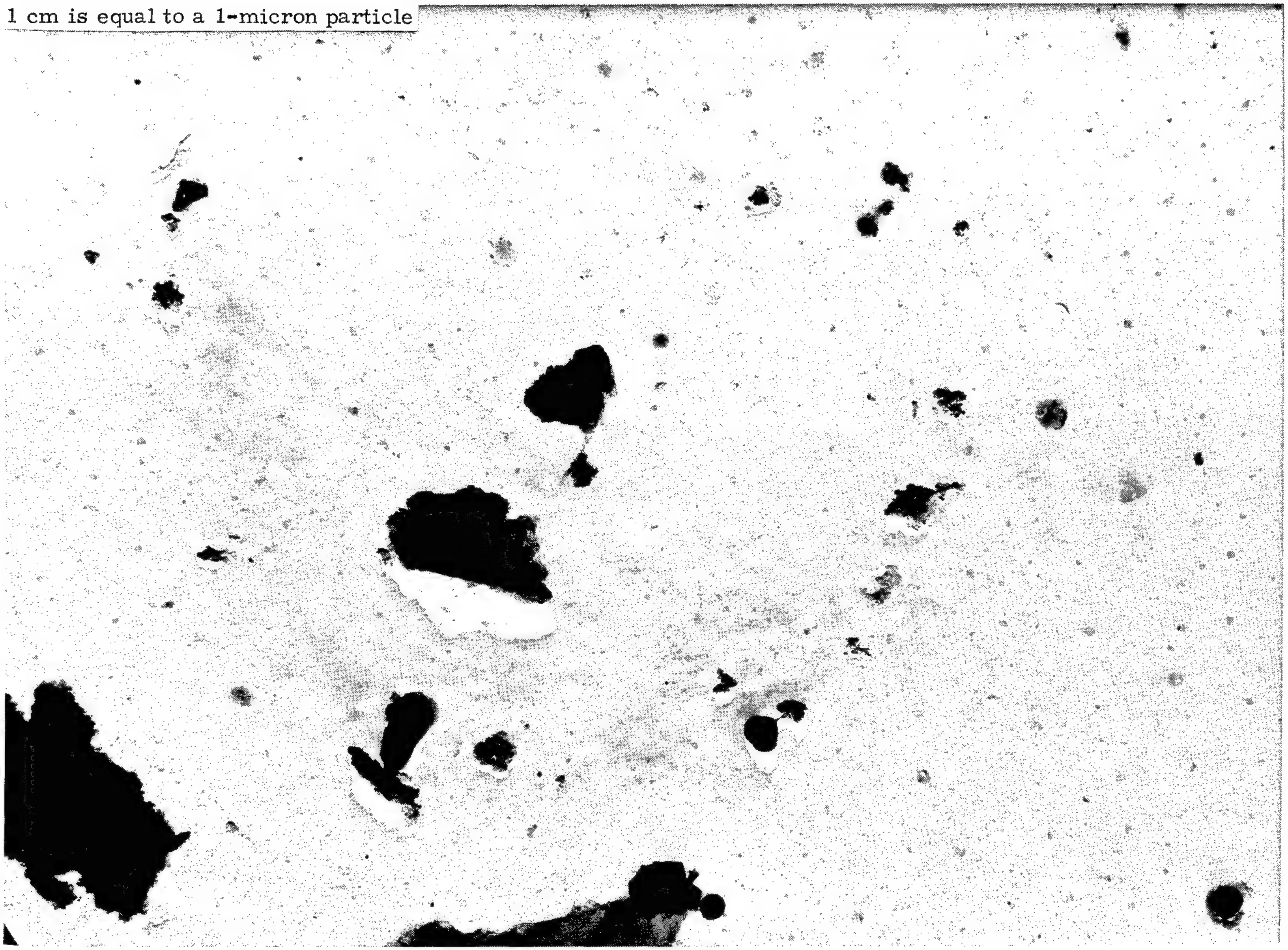


Figure 63. Electron Micro-photograph of Graphite Particles Showing Extreme Variation of Size and Shape of Particles Less Than 1 Micron

The objects which were identifiable and trackable are as follows:

1. Skin Sections (1 through 5)
2. Graphite Jets (North, South, East, and West)
3. Vertical Graphite Jet (with Nozzle), Nozzle Return, and Nozzle Ring Return
4. Control Drums (7 and 10)

The skin section data from the trajectory tabulations (Table E-1, Appendix E) are plotted on Figure 64. However, the only velocity considered to be of value is the piece called Skin 1 or that piece which included the reflector segment numbers 7, 8, and 9. All other skin sections were possibly restricted in their flight by an obstruction placed in their flight path. Figure 65 is a two-dimension debris plot which shows the reflector segment numbers and the location of objects which interfere with free flight of the skin sections.

The graphite jet data from the trajectory tabulations (Table E-2, Appendix E) are plotted on Figure 66 and show the effect of impact on the velocity measuring stands placed in the South and West jets. The difference in the velocity drop between the South and West jets is caused by the difference in location of the obstruction--50 feet on the South jet and 70 feet on the West jet. The velocity data from the North and East jets show the effects of aerodynamic deceleration on the graphite debris from the reactor core.

The vertical graphite jet, nozzle return, and nozzle ring return data from the trajectory tabulations (Table E-3, Appendix E) are plotted on Figure 67 and show the vertical graphite jet accelerating and then decelerating. Further, the return of the simulated nozzle and the nozzle mounting ring are plotted.

The control drum data from the trajectory tabulations (Table E-4, Appendix E) are plotted on Figure 68. Six control drums were recovered, but only two of these could be tracked accurately. One control drum hit a velocity measuring device structure, and three control drums were not identifiable as to direction of flight and therefore could not be tracked, even though they were located in the photographic film.

These velocity data, along with the velocity obtained from the glass rod velocity devices and the rotating foam velocity devices, are plotted on Figure 69. The data agree well and show the velocity range in which each device operates to the best advantage.

Two-Dimensional Debris Distribution

All pieces of the mockup space engine located were identified as to location (angle and distance) and were weighed. The recovered pieces are tabulated in Table IV. This table identifies the recovered pieces, gives its weight, and shows the angle and distance from ground zero. The angle is measured clockwise from a line running through ground zero and the center of the hard surface pad. Figure 65 plots the data contained in Table IV and shows the two-dimensional debris locations and the orientation of the hard surface pad with respect to ground zero. Note that the North jet line is the zero degree orientation line.

The center of the plot (ground zero) has been expanded for clarification in Figure 65 and shows the obstructions to debris flight as well as the orientation of engine components prior to the destruct test.

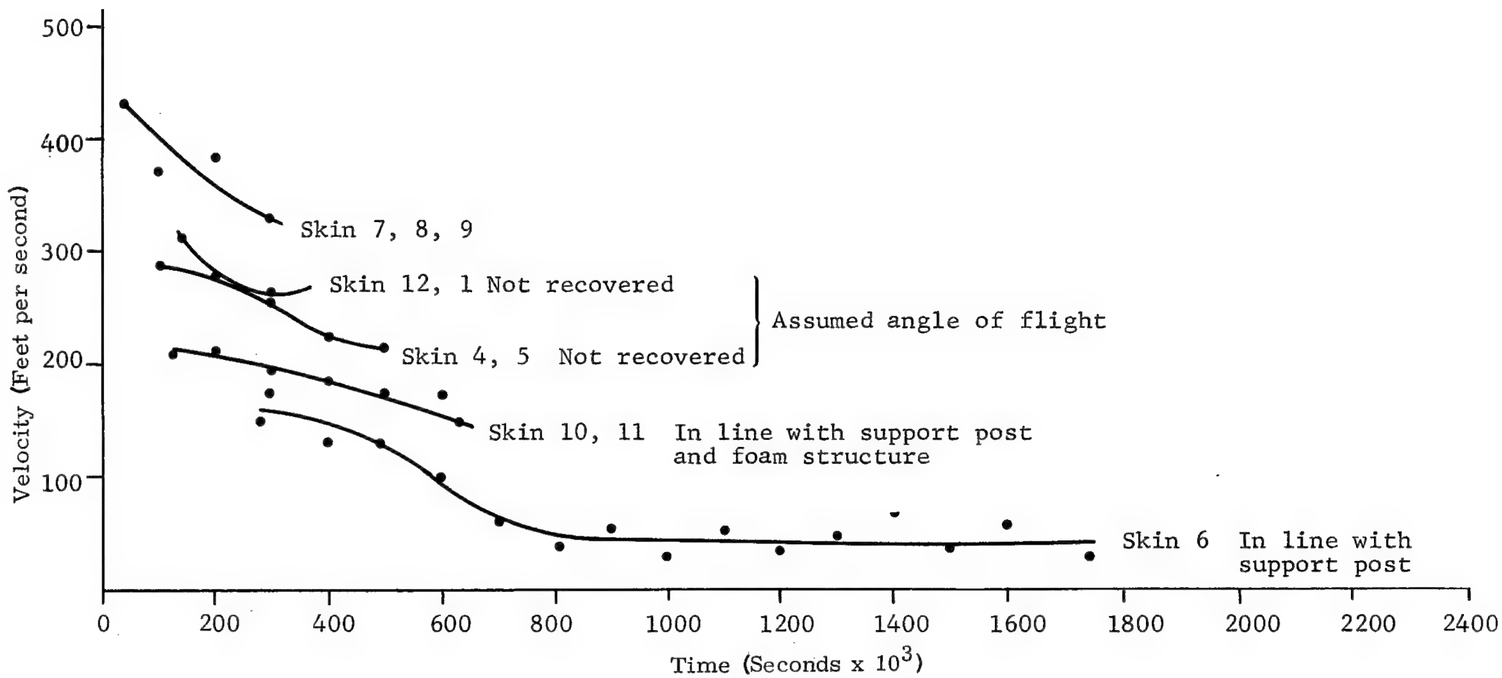


Figure 64. Velocities Observed for Section of Center Section Skin

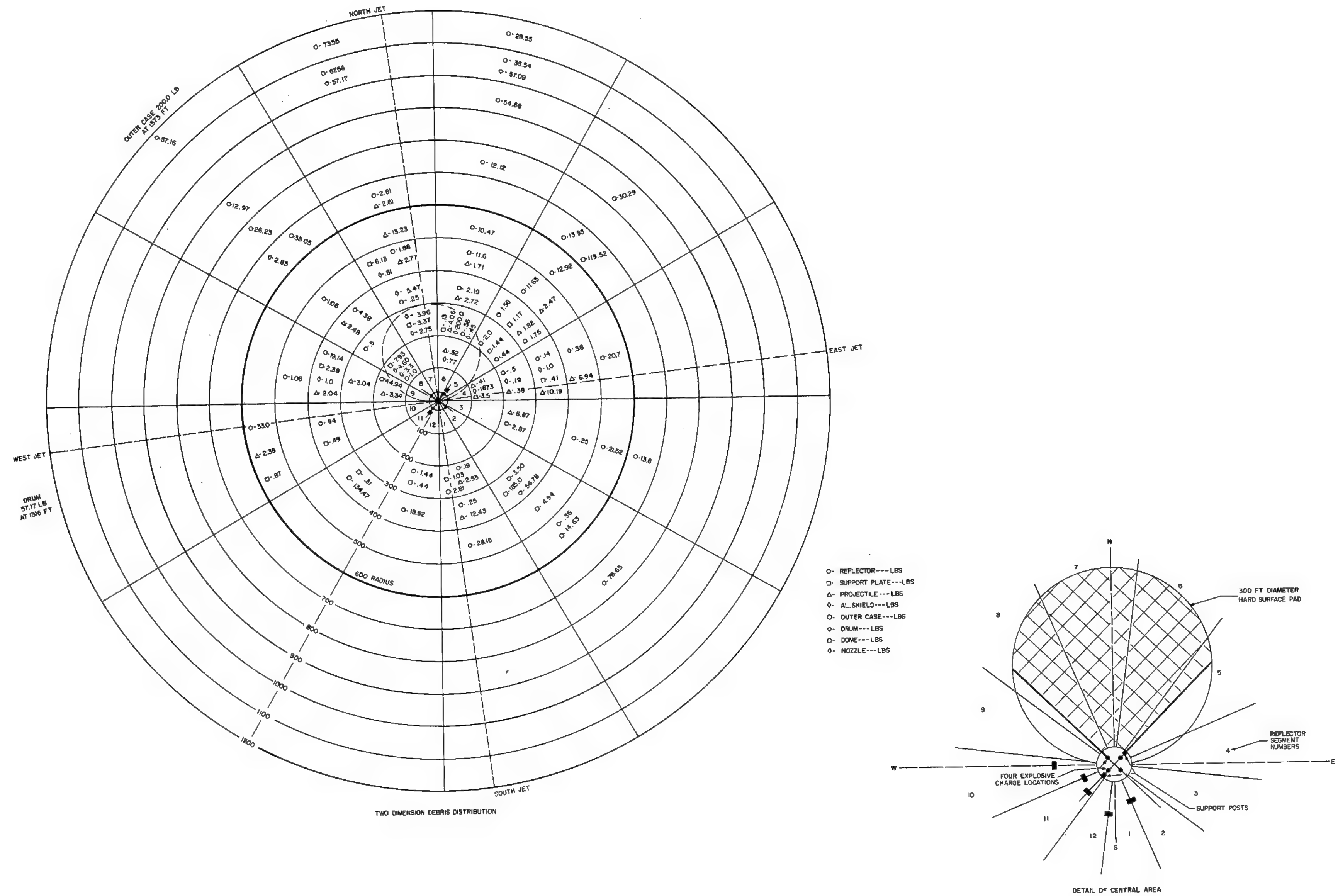


Figure 65. Two-Dimensional Debris Plot

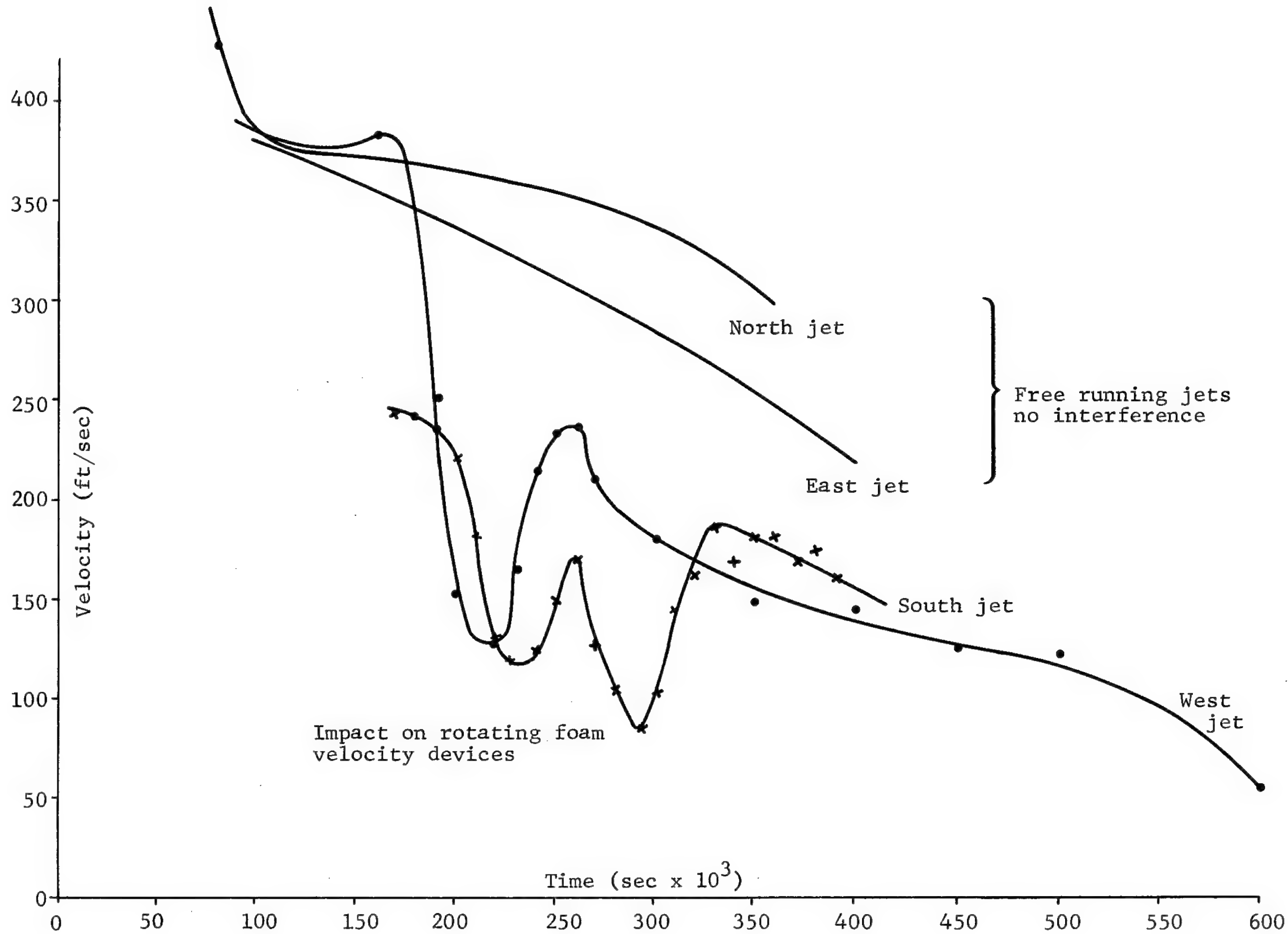


Figure 66. Velocities Observed for Horizontal Graphite Jets

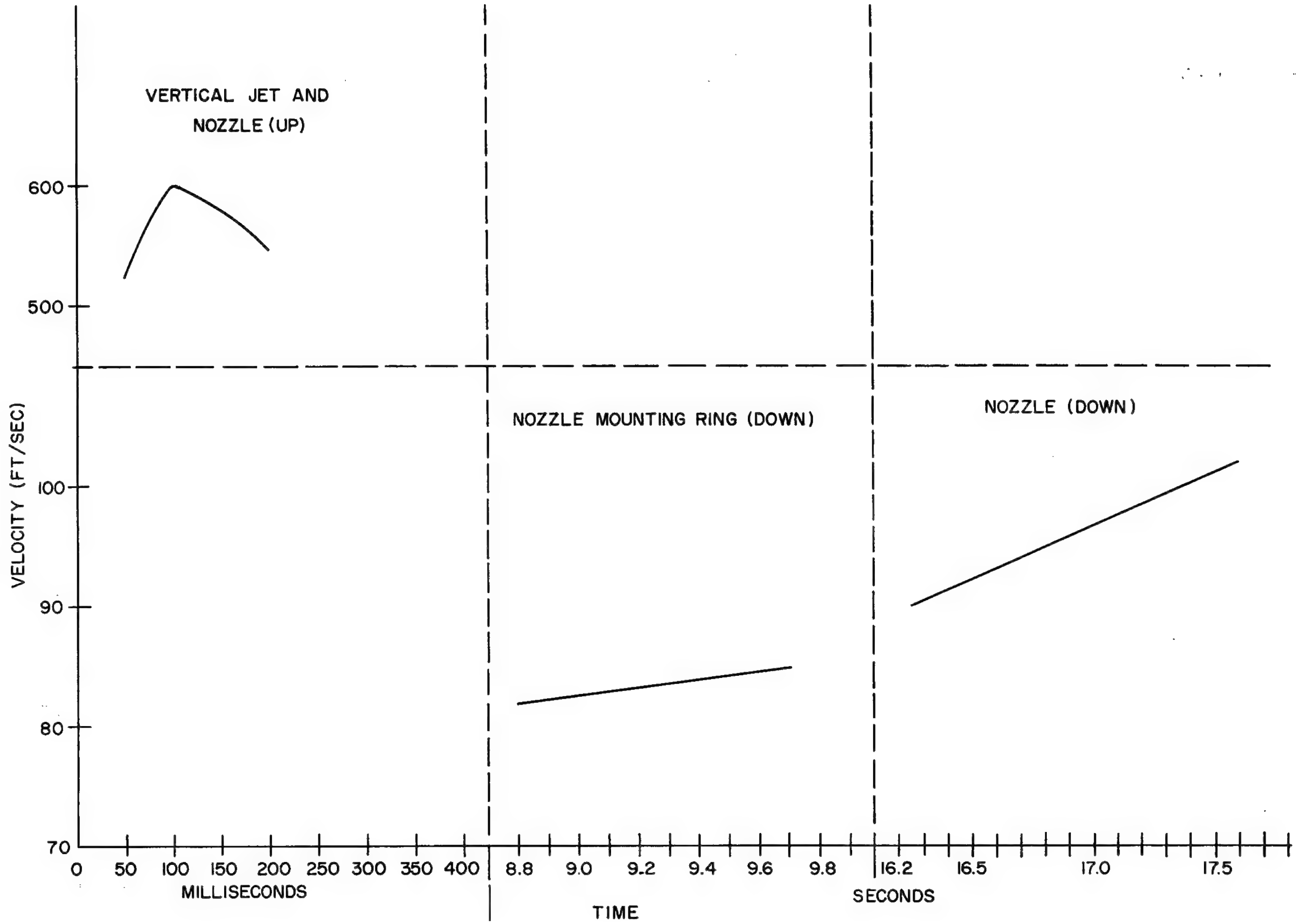


Figure 67. Velocities Observed for Nozzle Components

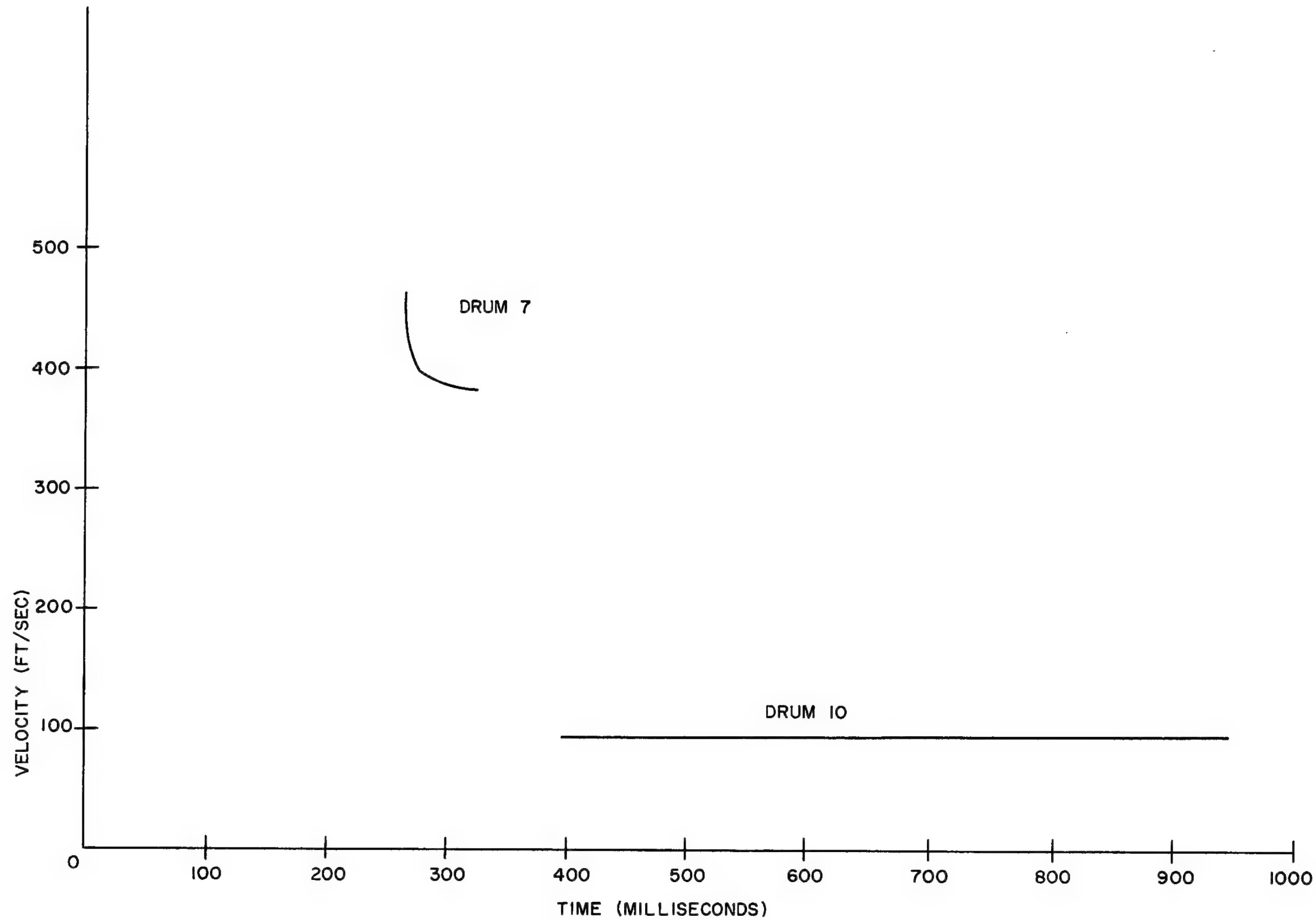


Figure 68. Velocity for Simulated Control Drums

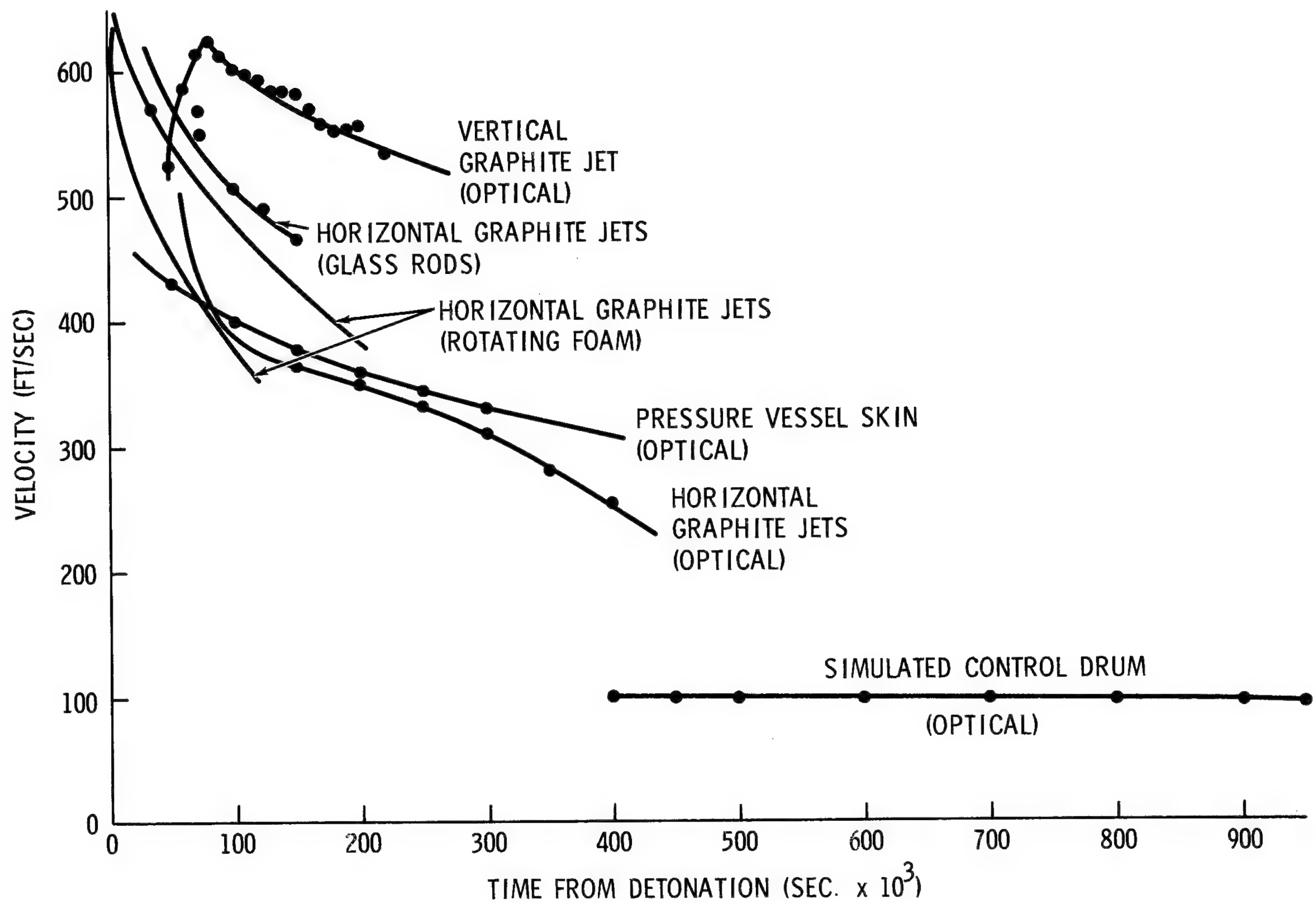


Figure 69. ROVER/NERVA Full-Scale Destruct Time from Detonation versus Typical Measured Velocity

TABLE IV

Tabulated Debris Distribution Data
(Prepared by Aberdeen Proving Ground)

Item No.	Nomenclature	Weight (lbs)	*Angle (degrees)	Distance (ft)
1	Reflector	10.75	258°45'	538
2	Reflector	0.94	263°13'	394
3	Reflector	11.47	249°53'	552
4	Outer case	134.47	235°41'	393
5	Support plate flange	0.31	227°05'	357
6	Support plate	0.44	211°53'	298
7	Reflector	1.44	209°08'	291
8	Reflector	11.52	196°23'	346
9	Reflector	7.0	191°41'	338
10	Reflector	28.16	183°52'	454
11	Reflector	57.56	147°40'	727
12	Reflector	21.09	135°16'	737
13	Reflector	21.52	126°12'	567
14	Reflector	14.63	133°26'	487
15	Support plate	0.36	134°11'	455
16	Support plate	2.38	143°53'	375
17	Outer case	185.0	138°53'	245
18	Control drum	56.78	138°32'	238
19	Not identified		140°08'	256
20	Reflector	1.44	145°05'	298
21	Support plate flange	2.56	140°20'	348
22	Reflector	0.31	132°57'	297
23	Reflector	0.87	133°43'	262
24	Reflector	0.88	127°15'	265
25	Projectile	4.0	115°20'	250
26	Projectile	2.87	114°46'	226
27	Reflector	1.10	109°50'	224
28	Not identified		121°39'	183
29	Projectile	2.57	90°16'	345
30	Projectile	2.57	90°50'	343
31	Shield	1.0	88°50'	343
32	Projectile	2.41	89°24'	360
33	Support plate	0.41	85°21'	363
34	Projectile	2.64	83°03'	371
35	Shield	0.38	83°51'	412

TABLE IV (cont)

Item No.	Nomenclature	Weight (lbs)	*Angle (degrees)	Distance (ft)
36	Projectile	2.80	$81^{\circ}18'$	419
37	Reflector	12.11	$64^{\circ}25'$	526
38	Reflector	0.81	$54^{\circ}41'$	513
39	Reflector	11.09	$42^{\circ}08'$	464
40	Reflector	0.81	$43^{\circ}56'$	354
41	Projectile	2.47	$47^{\circ}38'$	417
42	Reflector	11.60	$30^{\circ}28'$	486
43	Reflector	10.47	$30^{\circ}12'$	535
44	Reflector	13.93	$38^{\circ}18'$	653
45	Outer case	117.52	$41^{\circ}41'$	693
46	Reflector	12.12	$30^{\circ}57'$	754
47	Reflector	2.19	$26^{\circ}52'$	982
48	Reflector	35.54	$47^{\circ}10'$	1042
49	Reflector	6.91	$33^{\circ}04'$	1193
50	Reflector	30.29	$37^{\circ}10'$	814
51	Reflector	28.17	$8^{\circ}40'$	959
52	Reflector	21.64	$7^{\circ}45'$	1109
53	Reflector	5.91	$1^{\circ}11'$	1061
54	Reflector	16.30	$0^{\circ}38'$	1141
55	Reflector	13.74	$357^{\circ}09'$	1081
56	Reflector	23.61	$356^{\circ}29'$	1165
57	Reflector	27.46	$355^{\circ}52'$	1010
58	Reflector	20.45	$347^{\circ}37'$	1017
59	Reflector	33.64	$344^{\circ}49'$	1125
60	Control drum	57.16	$344^{\circ}40'$	1194
61	Outer case	200.0	$332^{\circ}49'$	1373
62	Reflector	10.78	$268^{\circ}31'$	569
63	Reflector	12.97	$311^{\circ}40'$	860
64	Reflector	4.17	$312^{\circ}53'$	779
65	Not identified		$329^{\circ}26'$	950
66	Reflector	20.0	$332^{\circ}39'$	780
67	Reflector	15.15	337°	633
68	Reflector	11.28	$9^{\circ}30'$	964
69	Reflector	12.54	$10^{\circ}42'$	971
70	Control drum	57.09	$9^{\circ}07'$	1999
71	Control drum	57.17	$0^{\circ}17'$	1671
72	Support plate	0.87	$272^{\circ}01'$	503
73	Reflector	11.39	$309^{\circ}04'$	654

TABLE IV (cont)

Item No.	Nomenclature	Weight (lbs)	*Angle (degrees)	Distance (ft)
74	Reflector	11.51	$310^{o}27'$	674
75	Reflector	2.06	$310^{o}05'$	709
76	Reflector	18.22	$307^{o}45'$	813
77	Dome flange	2.85	$320^{o}12'$	609
78	Reflector	1.06	$327^{o}30'$	488
79	Projectile	2.48	$330^{o}28'$	339
80	Reflector	2.50	$318^{o}47'$	316
81	Reflector	1.88	$319^{o}12'$	348
82	Aluminum shield	1.47	328^{o}	154
83	Aluminum shield	1.03	$341^{o}08'$	165
84	Aluminum shield	0.89	$342^{o}51'$	160
85	Aluminum shield	0.40	$348^{o}41'$	180
86	Aluminum shield	1.64	$357^{o}57'$	188
87	Dome flange	2.75	$357^{o}26'$	168
88	Aluminum shield	1.35	$1^{o}42'$	202
89	Not identified		$07^{o}53'$	239
90	Aluminum shield	0.45	$09^{o}23'$	226
91	Not identified		$09^{o}23'$	226
92	Nozzle	200.0	$16^{o}03'$	205
93	Projectile	1.92	$27^{o}52'$	221
94	Projectile	0.52	$25^{o}30'$	192
95	Not identified		$15^{o}11'$	129
96	Aluminum shield	0.77	$23^{o}02'$	106
97	Projectile	0.57	$341^{o}06'$	66
98	Not identified		$338^{o}36'$	84
99	Projectile	0.48	$338^{o}02'$	92
100	Nozzle flange	46.0	$331^{o}57'$	102
101	Aluminum shield	0.79	$318^{o}54'$	133
102	Support plate	3.37	$352^{o}29'$	146
103	Projectile	3.34	$302^{o}19'$	99
104	Aluminum shield	2.14	$92^{o}50'$	103
105	Projectile	0.41	$94^{o}50'$	104
106	Aluminum shield	1.05	$82^{o}22'$	137
107	Aluminum shield	1.41	$83^{o}00'$	135
108	Aluminum shield	1.57	$67^{o}51'$	118
109	Aluminum shield	1.06	$67^{o}51'$	118
110	Aluminum shield	1.56	$69^{o}52'$	136
111	Dome	3.50	$68^{o}09'$	169

TABLE IV (cont)

Item No.	Nomenclature	Weight (lbs)	*Angle (degrees)	Distance (ft)
112	Aluminum shield	2.94	$81^\circ 12'$	179
113	Aluminum shield	0.19	$71^\circ 41'$	213
114	Projectile	0.38	$69^\circ 52'$	239
115	Reflector	0.5	$68^\circ 42'$	247
116	Support plate flange	2.0	$55^\circ 14'$	276
117	Reflector	0.44	$51^\circ 18'$	242
118	Dome flange	1.44	$49^\circ 11'$	298
119	Support plate	1.17	$62^\circ 09'$	343
120	Projectile	1.82	$64^\circ 32'$	316
121	Reflector	0.56	$66^\circ 42'$	419
122	Reflector	1.19	$34^\circ 53'$	355
123	Not identified		$43^\circ 57'$	315
124	Reflector	0.75	$44^\circ 22'$	308
125	Projectile	2.72	$24^\circ 37'$	379
126	Reflector	0.25	$26^\circ 30'$	299
127	Projectile	2.14	$28^\circ 50'$	297
128	Reflector	0.81	$14^\circ 24'$	327
129	Reflector	0.19	$12^\circ 10'$	314
130	Reflector	0.13	$11^\circ 08'$	301
131	Support plate	0.13	$10^\circ 28'$	305
132	Support plate	0.81	$4^\circ 25'$	324
133	Not identified		$04^\circ 13'$	321
134	Reflector	0.25	$3^\circ 27'$	320
135	Reflector	0.13	$4^\circ 24'$	315
136	Aluminum shield	0.81	$0^\circ 16'$	353
137	Reflector	0.56	$4^\circ 40'$	378
138	Projectile	0.85	$5^\circ 15'$	380
139	Projectile	3.12	$2^\circ 29'$	410
140	Projectile	1.71	$13^\circ 02'$	440

TABLE IV (cont)

Item No.	Nomenclature	Weight (lbs)	*Angle (degrees)	Distance (ft)
141	Projectile	1.19	$1^{\circ}12'$	468
142	Projectile	2.67	$0^{\circ}7'$	481
143	Reflector	0.37	$359^{\circ}30'$	361
144	Projectile	1.95	$357^{\circ}27'$	416
145	Support plate flange	3.74	$355^{\circ}35'$	398
146	Projectile	2.55	$354^{\circ}57'$	425
147	Projectile	1.23	$348^{\circ}38'$	469
148	Projectile	0.52	$347^{\circ}16'$	490
149	Reflector	2.81	$344^{\circ}42'$	554
150	Projectile	2.61	$340^{\circ}30'$	544
151	Support plate	0.06	$344^{\circ}33'$	367
152	Projectile	1.92	$346^{\circ}17'$	326
153	Reflector	0.38	$347^{\circ}21'$	319
154	Aluminum shield	3.09	$354^{\circ}24'$	302
155	Reflector	0.19	$356^{\circ}43'$	310
156	Support plate	0.41	$1^{\circ}22'$	309
157	Not identified		$346^{\circ}43'$	289
158	Aluminum shield	1.03	$344^{\circ}24'$	293
159	Reflector	0.25	$340^{\circ}12'$	304
160	Support plate	1.11	$338^{\circ}37'$	312
161	Reflector	0.25	$330^{\circ}09'$	288
162	Reflector	0.25	$333^{\circ}11'$	271
163	Not identified		$333^{\circ}30'$	255
164	Projectile	2.04	$286^{\circ}13'$	320
165	Support plate flange	2.38	$281^{\circ}26'$	364
166	Aluminum shield	1.0	$284^{\circ}07'$	396
167	Reflector	19.14	$277^{\circ}26'$	395
168	Reflector	1.06	$280^{\circ}55'$	458
169	Not identified		$282^{\circ}23'$	503

TABLE IV (cont)

Item No.	Nomenclature	Weight (lbs)	*Angle (degrees)	Distance (ft)
170	Projectile	2.39	276°01'	504
171	Support plate	0.49	273°42'	349
172	Projectile	3.04	277°39'	256
173	Support plate	7.60	317°36'	129
174	Support plate	0.25	317°36'	129
175	Not identified		317°36'	129
176	Support plate	0.08	317°36'	129
177	Aluminum shield	1.04	319°18'	142
178	Projectile	0.47	319°18'	142
179	Reflector	1.0	308°03'	98
180	Reflector	13.10	285°24'	120
181	Reflector	31.84	284°17'	147
182	Projectile	2.48	184°24'	391
183	Projectile	2.58	186°08'	366
184	Projectile	2.37	181°30'	356
185	Projectile	2.0	175°35'	330
186	Projectile	3.0	172°29'	351
187	Projectile	2.55	180°37'	285
188	Not identified		178°28'	303
189	Reflector	0.25	177°12'	308
190	Support plate	0.49	172°	263
191	Support plate	0.54	175°40'	234
192	Not identified		178°18'	232
193	Outer case support	2.81	173°35'	298
194	Not identified		170°48'	311
195	Reflector	0.25	123°30'	422
196	Reflector	13.80	97°44'	675
197	Projectile	4.14	94°16'	497
198	Reflector	20.70	89°27'	528

TABLE IV (cont)

Item No.	Nomenclature	Weight (lbs)	*Angle (degrees)	Distance (ft)
199	Reflector	0.14	$89^{\circ}41'$	311
200	Dome	1.75	$39^{\circ}11'$	364
201	Not identified		$39^{\circ}11'$	364
202	Not identified		$161^{\circ}26'$	184
203	Reflector	0.19	$173^{\circ}33'$	223
204	Control drum	57.17	$262^{\circ}10'$	1316

*The zero degree line passes through ground zero and the center of the hard surface pad. Angles are measured clockwise.

Weight of Components Assembled into Mockup Propulsion Engine	Pounds
Outer case	950.0
Segments outer reflector	1722.0
Control drums (dummy 12 ea)	687.0
Dome (308 lb/foam)	910.0
Graphite barrel	500.0
Support plate/support ring	472.0
Nozzle	250
Aluminum liner	60
Support wire core (234 ea)	37.44
Aluminum tubes	10.70
Graphite segments	107.65
Graphite filler	15.91
Graphite (half rods)	77.30
Graphite (center rods)	288.50
Graphite rods (loaded)	2165.77
Projectiles	334.25
	8588.52

The distribution of debris indicates a radial flight pattern for the metallic fragments of the space engine. Note that the pressure vessel skin, the control drums, and the reflector segments are distributed very symmetrically and, where identification was possible, each fragment remained in the radial arc where it originated.

Even though there were obstructions in segments 1, 2, 5, 10, 11, and 12, the distribution of metallic components within a 600-foot radius is reasonably symmetrical. Outside the 600-foot radius, data were so incomplete that the distribution can only be assumed. Segments 6, 7, and 8 indicate that the distribution remains radial and that a radius of about 1500 feet is needed to obtain a more representative two-dimensional plot. Note in Table V the percent of recovery out to 600 feet and out to 1200 feet.

Although the location of the metallic debris shows a radial pattern, the core and graphite reflector follow a very different debris pattern. The graphite materials along with the projectile debris flow within the core cavity and are propelled into the 4-jet pattern radially and into a vertical column (nozzle vertical in this test). The locations of the four radial jets were located as in Figure 65. The jets were photographed from a helicopter immediately after the destruct test (Figure 70). Figure 71 shows the vertical jet with the nozzle riding the top.

The recovered debris from this test indicate that the average fragment size for each major component is as follows:

Core - 0.12 inch diameter or 3.0 mm

Core Support Plate - 0 - 10 lbs = 1.69 lbs, 10 - 100 lbs = 55.40 lbs

Aluminum Barrel - 0 - 10 lbs = 1.21 lbs

Reflector Segments - 0-10 lbs = 1.45 lbs, 10 - 20 lbs = 13.32 lbs, 20 - 30 lbs = 23.64 lbs,
30 - 40 lbs = 33.16 lbs, 50 - 60 lbs = 57.56 lbs, 60 - 225 lbs = 203.09 lbs

Control Drums - Intact

Center Pressure Vessel Skin - 0 - 10 lbs = 2.81 lbs, 100 - 200 lbs = 139.25 lbs

Pressure Vessel Dome - 0 - 10 lbs = 2.22 lbs, 10 - 20 lbs = 17.96 lbs, 20 - 30 lbs = 20.35 lbs,
30 - 50 lbs = 38.22 lbs, 50 - 110 lbs = 106.53 lbs

Nozzle - Intact

Projectile - 0 - 10 lbs = 2.01 lbs, 10 - 40 lbs = 18.93 lbs

TABLE V

Debris Distribution (Percent by 30-degree Segments)

Inside 600 Feet Radius							Outside 600 Feet Radius								
Reflector	Aluminum Shield	Outer Case	Control Drum	Projectile	Support Plate	Nozzle	Reflector	Aluminum Shield	Outer Case	Control Drum	Projectile	Support Plate	Nozzle	Segment Nos.	Horizontal Graphite (Jet)
19.9	0		0	82.8	2.6	0	0	0	0	0	0	0	0	1	J
12.6	0	79.1	0	0	13.5	0	54.8	0	0	0	0	0	0	2	
17.2	0		0	38.0	0	0	9.6	0		0	0	0	0	3	
15.1	124.5		0	99	1.0	0	0	0		0	0	0	0	4	J
18.5	0	0	0	23.7	8.1	0	30.8	0	49.5	0	0	0	0	5	
17.6	16.7		0	49.8	0.3	80.0	91.2	0		100	0	0	0	6	
10.7	69.6		0	88.5	24.1	1.1	100.3	0		100	14.4	0	0	7	J
4.8	27.5	0	0	13.7	20.2	18.4	53.8	0	84.2	100	0	0	1.1	8	
45.4	8.3		0	46.6	6.0	0	0	0		0	0	0	0	9	
23.6	0		0	13.2	3.4	0	0	0		100	0	0	0	10	J
0	0	56.6	100	0	7.9	0	0	0	0	0	0	0	0	11	
13.9	0		0	0	11.2	0	0	0		0	0	0	0	12	

NOTE: The figures in this table are percentages of the total material expected when assuming radial distribution and assuming total collection inside 600 or outside 600 feet.

*See Figure 65.

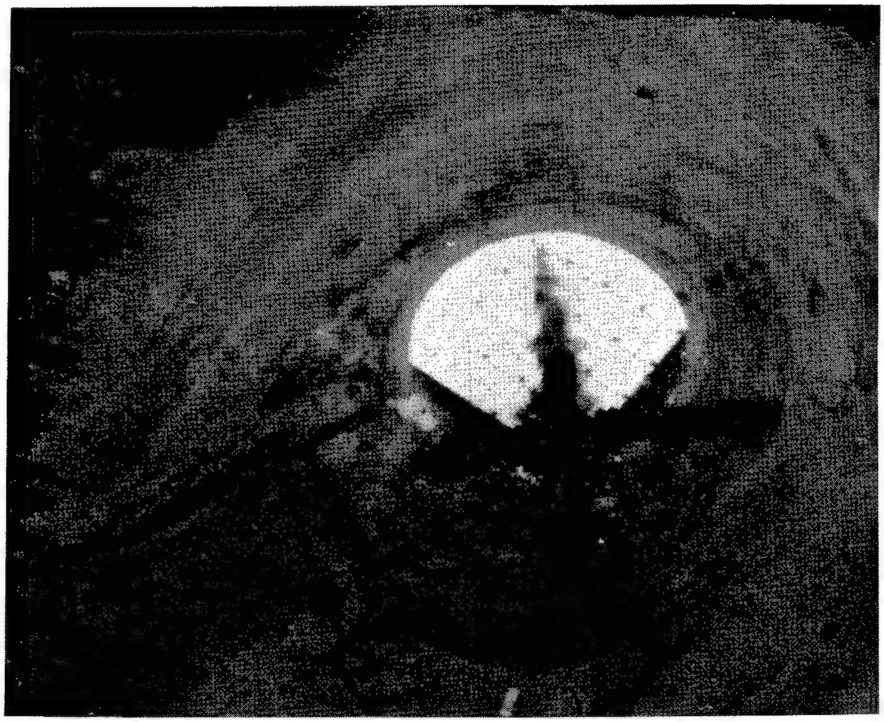


Figure 70. Horizontal Graphite Jets

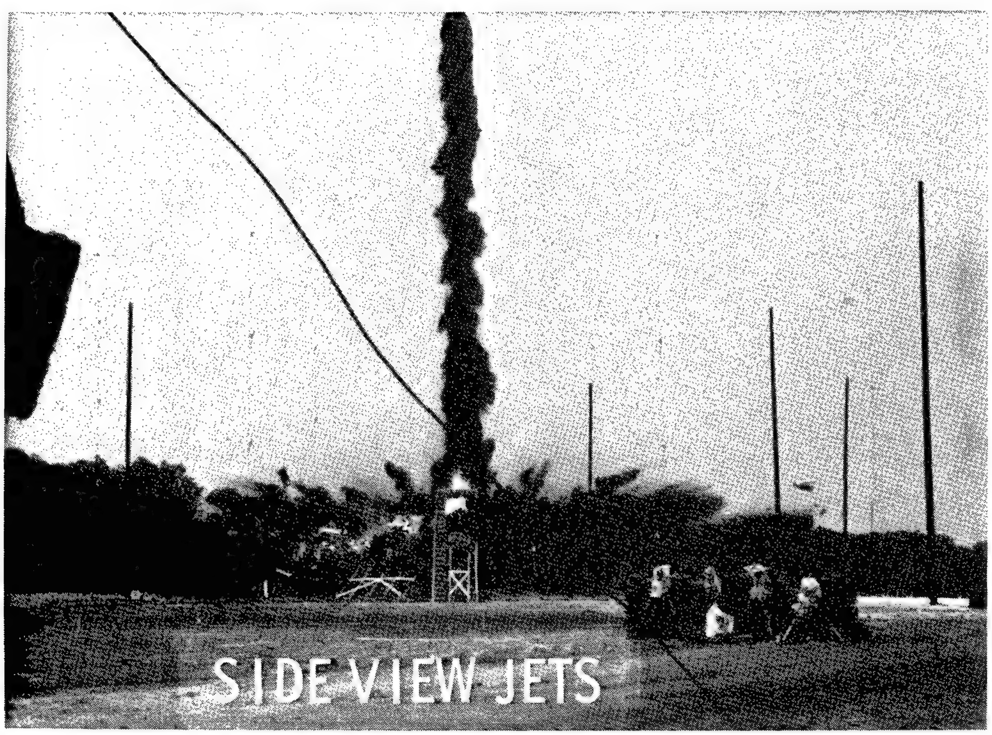


Figure 71. Vertical Graphite Jets

Conclusions and Recommendations

The postoperational destruct test of the ROVER/NERVA mockup space propulsion engine was successful. The data acquired by the instrumentation are a good representation of the destruct event, even though the destruction of instrumentation was far greater than anticipated. The destructive force occurred after data collection and therefore did not wipe out instrumentation but did reduce the quantity of data gathered.

All instrumentation systems functioned satisfactorily, with complete data recovery from pressure instrumentation and partial data recovery from all other systems.

Air sampling and particle collection data are marginal but considered to represent the true particle distribution.

Velocity measurement data are sketchy, but sufficient duplication of systems produced data which gave a representative evaluation of the velocities of reactor components.

Although the destruct test was a success, future tests should produce superior data because the experience and knowledge acquired from this test will promote the development of better instrumentation and a better placement of instruments.

Changes which should be incorporated on future tests to produce more complete and superior data are:

1. Suspend the mockup propulsion engine at a greater height above the ground, with the nozzle toward the ground.
2. Provide a larger hole below the propulsion engine and line this hole with foam blocks, bonded to each other and to the hole walls.
3. Position the fixed foam particle collector on the ground and framed in a more rigid structure (a position possible with the engine nozzle down).
4. Position the rotating foam velocity devices on the ground and frame these devices more rigidly to withstand impact and blast overpressure.
5. Redesign the timing systems on all rotating devices to allow direct velocity reduction from raw data, and redesign the twin disc for better particle collection and for reduction of particle breakup.
6. Use a larger cleared area to give more complete debris distribution data.
7. Use more duplication on photographic instrumentation to allow use of both long and short focal length lenses which would provide better debris identification while the debris is in flight.
8. Provide more pressure instrumentation, both within the core and at greater distances from ground zero.

APPENDIX A

COORDINATED PLAN OF TEST
FOR
AN ENGINEER DESIGN TEST
OF
A DESTRUCT SYSTEM FOR A SIMULATED
FULL SCALE NERVA REACTOR

COPY

COPY

ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND

COORDINATED PLAN OF TEST
FOR
AN ENGINEER DESIGN TEST
OF
A DESTRUCT SYSTEM FOR A SIMULATED
FULL SCALE NERVA REACTOR

RDT&E PROJECT NO. N/A

USATECOM PROJECT NO. 5-5-8410-02

Prepared by: George F. Lefevre (APG)
Lt. Boyd McNaughton (APG)
Mr. R. Berry (Sandia)

FOR THE COMMANDER:

J. A. TOLEN
Assistant Deputy Director
for Engineering Testing
Development and Proof Services

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PART I - APG-D&PS

1. INTRODUCTION

The Space Nuclear Propulsion Office of AEC-NASA, in connection with its development of a nuclear engine for space application, has generated a need for data on the performance of an explosive destruct safety system. The feasibility of an explosive destruct system was established in an experiment conducted in March 1963. However, additional data are now needed to provide a complete description of the explosive destruct functioning evnironment in terms of fragment size, velocity and direction.

2. BACKGROUND

The participation of APG in the ROVER flight safety program commenced in March 1961 with the objective of developing a means of destroying a nuclear rocket engine. Two proposals were submitted by APG. The first suggested the firing of a penetrating projectile to explode within the reactor. The second proposal was to accomplish destruction using a multiple shaped charge arrangement. This second method was proven unfeasible. The role of APG was then limited to studies of the penetrating explosive-projectile type of destruct.

The feasibility tests were phased as follows:

a. Graphite penetration studies.

b. Projectile design studies.

c. Full scale destruct test.

Several scale model tests and two full scale model tests were conducted. The feasibility of this destruct system was confirmed.

Following the explosive destruct feasibility experiments, Picatinny Arsenal was selected as the design agency to evolve an optimized destruct projectile and associated hardware. Picatinny Arsenal models are being supplied for the current test.

In this period since March 1963, APG has been authorized to study test techniques to improve data acquisition on future destruct experiments. Among the techniques examined have been graphite fragment recovery, and classification, graphite fragment velocity measurement and graphite fragment aerodynamics.

Sandia Corp. has also been authorized to study explosive destruct test techniques and has conducted a number of experiments with scale model devices. The testing skill available at Sandia and APG, has led SNPO to decide on a joint participation by both APG and Sandia in the forthcoming full-scale destruct experiment. Each will conduct

independent evaluations and submit their findings in separate reports to NASA.

The test technique studies have shown that a full scale destruct experiment is feasible with an excellent chance of measuring the desired information. The full scale reactor model will be placed in a vertical position with the base about 5-feet above the ground.

Functioning of the four destruct projectiles will result in nearly horizontal projection of the graphite fragments. The fragments will expend most of their energy to the atmosphere and come to rest on a large smooth surface.

The test technique studies and the previous full scale reactor shot have shown that about one-half of the reactor graphite fragments into particles that will become airborne. This makes air sampling a necessity in the forthcoming test, and methods have been investigated to accomplish this.

3. OBJECTIVE

To determine the destructive effects of four (4) 105mm special projectiles on a pilot model rocket engine device.

To determine fragment size and weight distribution, velocity, and direction resulting from the destruct.

To determine the graphite content of the smoke cloud generated during the destruct.

4. RESPONSIBILITIES

The Mortar and Recoilless Rifle Branch, Artillery Division, shall have overall responsibility of the test program, and shall write the final technical report.

High speed photography (Benson Lehner, Fastax, Smear and Mitchell cameras) will be the responsibility of Photographic Engineering Section.

The Geodetic Measurement and Observation Section shall be responsible for the emplacement and operation of the Akeley Theodolites.

The Technical Photographic Laboratory shall be responsible for documentary films and still photographs of the program.

Analytical Laboratory shall be responsible for reducing film data and submitting a report on fragment velocity and distribution.

Materials Evaluation Laboratory is responsible for determining size, weight, density and uranium content of recovered particles from

the cloud and ground. They shall also perform microscopic examinations of a sample of particles and determine the amount of uranium recovered and/or lost.

Sandia shall conduct an independent evaluation of the destruct and submit their findings in a separate report. APG will provide test support as requested in Sandia's attached test outline and as amended by the coordination review.

5. DESCRIPTION TEST MATERIAL

The NERVA reactor is a nuclear engine that can fit inside a pressure vessel which has an inside diameter of approximately 50-inches and is approximately 92-inches long (measured from nozzle flange to inside of dome). The reactor generally consists of a shield, flow screen, the outer reflector, and the core assembly which is composed of the core proper and the inner reflector.

The individual components of the test item received at APG were not the same as the actual reactor, however, they were similiar. These components were modified and assembled to simulate the nuclear reactor as close as possible. The assembled test items total weight is approximately 8400 lbs. The optimized destruct system inside the test item consists of four (4) 105mm special projectiles furnished by Picatinny Arsenal. The projectiles are positioned equidistant from the core center at 90 degree intervals. Static detonation of these projectiles will be accomplished through an electrical network also provided by Picatinny Arsenal.

6. TEST PROCEDURE

6.1 GENERAL

The test shall be conducted in a cleared and level area whose diameter is approximately 600 feet. The test item will be mounted with its longitudinal axis perpendicular to the ground. The nozzle (base) shall be 5-feet above ground level. Static detonation of the four (4) 105mm special destruct projectiles within the core shall be triggered electrically and accompanied with a count down. Sufficient instrumentation will be used to meet the test objectives.

6.2 FRAGMENT VELOCITY MEASUREMENTS

Four (4) special velocity targets will be fabricated. They shall be 8-feet high and 2-feet wide. The targets shall be vertically positioned on a 25' diameter circle from ground zero. The center of the targets shall be facing and at the same height above the ground as the center of the test item. One target shall be placed on the West Jet line and the other targets spaced 2-feet apart going from West to South Jet line.

A maximum of three (3) 16mm Fastax cameras will be used for target coverage. Two (2) 16mm Fastax cameras will supplement two (2) of the Mitchell cameras for velocity measurements.

6.3 FRAGMENTS AND AIR SAMPLING

6.3.1 Fragment Recovery

To aid the discussion of the methods of fragment recovery which will be used, three (3) general fragment size categories have been established.

a. Large fragments (generally larger than 1000 microns mean spherical diameter) whose trajectory will not be strongly affected by a moderate (5 to 10 mph) wind.

b. Intermediate fragments (roughly between 1000 and 50 microns mean spherical diameter) whose trajectory will be strongly affected by a moderate wind but which will fall to the ground in less than 300 feet.

c. Small fragments (less than 50 microns mean spherical diameter) which will be picked up by a moderate wind and carried for a distance greater than 300 feet.

The fragments in category a will be few in number so that a large sample must be obtained to achieve a reasonable statistical accuracy. To this end, all fragments which fall within a quadrant whose vertex is at the point of detonation will be collected. This quadrant will be paved for a distance of 300 feet from its vertex and will be divided into 25- foot by 25-foot squares. The fragments within each square will be picked up with a vacuum cleaner and identified by the square's location. The ground for a distance of 100 feet beyond the paved surface will be cleared and rolled flat. The fragments falling in this area will be picked up individually and identified by their distance and azimuth from the point of detonation.

The fragments in category b will be collected in 5-inch diameter battery jars placed on a 25-foot by 25-foot grid extending for a distance of 300 feet in all directions from the point of detonation. This will result in approximately 500 samples with a sampling ratio of approximately 8000 to 1. The exact dividing point between categories a and b will be determined during fragment analysis by examining the location distribution for the effects of wind on the trajectories of the particles.

The fragments in category c will be sampled by a vertical curtain of air samplers spaced 25-feet apart. This curtain will be 100 feet high, 300 feet in arc length and 300 feet downwind from ground zero. To insure that the fragment cloud passes through this curtain, a criterian for the shot is that a steady 7.5 $\pm$ 2.5 mph wind is blowing

4

in a direction of ± 45° degrees from magnetic north. A total of 48 impinger and 20 filterpaper type air samples will be used in the curtain. The sampling ratio will be equal to the ratio at the rate of flow of air through a 25 by 25 foot square to that through the air samplers. Since the sampling methods used for category b and c fragments compliment rather than duplicate each other, no dividing line will be established during fragment analysis.

6.3.2 Fragment Analysis

The fragment samples collected from the shot will be analyzed to obtain the following information:

a. Size distribution:

All fragments which will not pass through a standard No. 270 screen (53 micron opening) will be classified into approximately nineteen size groups with a Tyler Ro-Tap sieve shaker. The U.S. Standard square-root of the sieve series will be utilized.

All fragments which will pass through a No. 270 screen and larger than 0.5 micron mean spherical diameter will be sized with a Model B Industrial Coulter counter. The Coulter counter classifies particles by volume rather than by the particle's ability to fit through a square hole of known dimensions. To determine the relationship between these two methods of sizing a sample of the smallest five size classes obtained by sieving will also be sized on the Coulter counter. To establish the relationship between Coulter counter and microscope sizing, several samples will be sized with both the Coulter counter and with a calibrated microscope.

b. Weight Distribution:

A fragment weight distribution within a given size class will be determined for several selected samples. This will allow converting the fragment size distribution to a fragment weight distribution. Of course, the average particle weight of each size class can also be determined from these measurements.

c. Fragment Volume:

The average individual fragment volume for each size class will also be determined for several selected samples. This will allow a calculation of fragment density and the construction of a fragment volume distribution.

d. Uranium Content:

The uranium content of the material in each of the size classes will be determined by gamma analysis. This will allow the con-

struction of a uranium distribution curve as yielding an indication of the cleanliness of the samples.

e. Microscopic Examination:

The fragments in each size class will be examined visually with the aid of a microscope. Notes will be made concerning the general shape and surface texture. An effort will be made to quantitatively estimate the number of loose beads, both whole and broken. The dirt content of the smaller samples will also be estimated. Selected samples will be photographed.

After analysis, all or at least a representative portion of each sample will be saved for future reference.

All instruments used during analysis will be calibrated in accordance with D&PS calibration procedures. However, no attempt will be made to calibrate the sieves except to compare similar sieves from the two sets which will be used.

7. TEST SUPPORT REQUIREMENTS

7.1 TEST SITE (See attachment 1 & 2 Appendix IV)

Located at the Old Bombing Field area near the forty-foot (40') Drop Tower. An area whose diameter is approximately 300-feet will be surfaced with a black asphalt compound. The surface will be painted white and grided with 25-ft squares. The test item will be positioned at a point on the outer periphery of this surfaced area. The adjacent area for an overall diameter of approximately 600-feet will be cleared, smoothed, rolled and oiled. It also will be sectioned into 25-ft square grids. Reference stations will be established at the test site for camera orientation.

The test item shall be supported in a vertical position by a metal frame. Its base shall be approximately five (5) feet above ground level. Immediately below the base shall be a pit approximately 5' x 5' x 4' with energy absorbing material to capture the flying particles.

7.2 CAMERAS

a. A minimum of four (4) Mitchell cameras placed at 90° intervals around the device on a radius of approximately 500 to 600 feet.

b. A minimum of two (2) Fastax (16mm) cameras for overall coverage.

c. Two (2) Benson-Lehner cameras mounted in a helicopter for filming of jets and cloud formation.

d. Two (2) Akeley photo-theodolites positioned to measure cloud size and movement through the air samplers.

e. One (1) 35mm Smear camera to record detonator functioning for simultaniety.

f. One (1) each 16mm motion picture camera on the ground and in an aircraft (if available) for documentary purposes.

g. Additional cameras will be used as required for complete coverage.

7.3 OTHER

7.3.1 Meteorological

Ground meteorological data will be recorded at the test site.

7.3.2 Restraints

a. Black top recovery surface must be clean and dry prior to firing.

b. All personnel shall be under adequate cover for the firing.

c. Winds shall be from the Southwest and shall be 5 to 10 mph.

d. Shot will not be fired during inclement weather.

e. Prior to entry by other personnel after firing, the Radiation Safety Team shall enter the area and establish its safety with respect to radiation hazards.

f. The general level of illumination should be as high as possible, indicating a bright sunny day. Overcast or rain will seriously degrade photographic results because of the nature of the photographic subject.

8. DATA REDUCTION

Photographic coverage will be reviewed by the Analytical Laboratory in an effort to obtain a particle velocity pattern. Its correlation of particle size with velocity and distance will be evaluated. Cloud size and movement will also be determined. The volume of suspended particles in the smoke cloud will be estimated using this data and cloud sampling data.

The Materials Evaluation Laboratory will analyze the results of their recovery program to determine the particle size and distribution from the destruct. Uranium content shall be a major safety factor of consideration.

Each D&PS organization engaged in data analysis shall submit their findings, in report form to the Mortar and Recoilless Rifle Branch, for inclusion in the final report.

9. REPORTS

APG and Sandia will each submit separate test reports of their findings.

Test reports will be sent to SNPO, ATTN: Mr. H. Smith for distribution.

10. COORDINATION

The following coordination will be effected in the coordinated test effort: (References are to Sandia Test Plan)

a. APG will furnish Sandia four wooden poles, eight 18" eye bolts and sixteen 3-hole cable clamps as per Figure 1. Poles installed, at points 11 and 15 will be positioned at a greater distance than 130' from ground zero to clear black top sampling pad.

b. Pressure data will be recorded by Sandia. APG will furnish and install posts as per Figure 2.

c. W. R. detonators with a 5 micro-sec simultaniety will be furnished by Sandia.

d. The fixed foam box at the West Jet position will be eliminated (Fig. 3). The remaining box may be a free standing item instead of rigidly mounted to posts, and will be furnished by APG.

e. Platform B (Fig. 5) will be moved from West Jet position to South Jet position at a distance of 50-ft from ground zero.

f. Platforms and Foam Holders (Fig. 6, 7, 8 and 9) will be furnished and installed by APG.

g. APG will furnish sand and fill bags which Sandia will supply for use to protect cables and cameras.

h. APG will provide a floor and 3' high railing all around on the 40' drop tower for Sandia camera position.

i. The 2x4 posts 16' above ground (Fig. 10) are deleted. The surface area will be grided in 25-ft squares. From 25-ft to 100-ft from ground zero along the North Jet line, grid markings 10-ft long and spaced 5-ft apart will be added for photographic purposes.

j. APG will furnish Sandia seven (7) 30 kw - 3 ∅ generators for their power requirements.

k. Identification by markings of the individual parts of the test item will be made by APG. Assembly of the test item will be documented photographically.

l. Sandia will furnish a man and materials for making the foam for particle catchers and the test model dome.

m. APG will furnish office space for Sandia in Bldg 400, an overnight equipment storage-workshop van at the test site, and an additional workshop area in a building near the test site.

n. Sandia equipment will be flown (C54 or C47) into APG. Provisions will be made by APG for off loading and storing equipment near the test site.

o. APG will issue non-escort passes to Sandia personnel for security access to and from the test site. Sandia will furnish APG a complete list of personnel involved.

p. A review meeting of Project ROVER for this full-scale shot with all interested parties is scheduled at APG for 21 May 1965 in Conference Room B-1.

PART II - SANDIA CORPORATION

1. INTRODUCTION

Prior to the use of nuclear power supply materials in space these materials, their intended use, and the design safety criteria must be analyzed and approved for flight testing. The radiological hazard must be reduced to a level which can be tolerated during a launch pad failure, launch abort, short lived orbit or re-entry from orbit. These conditions can only be assured by the proper analysis and adequate dispersion of the radioactive material by burnup (micron particles) or other techniques. The dispersion technique used must be shown to distribute the materials either (1) above the earth for such a period of time that a minimum hazard exists, or (2) the radioactive material must be dispersed over the surface of the earth to such an extent that an acceptable level of contamination is attained.

Burnup during re-entry is one method of reducing the radioactive material to micron size and thereby promoting suspension in the atmosphere. However, when the test device becomes very large and the materials of construction are quite resistant to re-entry heat, then other measures must be taken to reduce the test device to particle sizes which will burn up or be dispersed in the upper atmosphere.

The ROVER (NERVA) propulsion reactor is a test device in the category of being large and constructed of heat resistant materials. A suitable destruct system has been developed for the post-operational destruction of the reactor, but a suitable safety analysis has not been completed. This analysis is necessary before flight testing can proceed.

To complete the safety analysis of the ROVER (NERVA) flight system, the following data is required.

a. Dynamics of Destruct Event

(1) Velocity of fragments of core, reflector, and pressure vessel as a function of fragment size and time.

(2) Angular distribution of fragments of core, reflector, and pressure vessel as functions of fragment size and time.

(3) Reconstruction of geometry of debris pattern of test as function of time on triaxial coordinate system.

(4) Extrapolation of geometry of (3) above to vacuum destruct condition on triaxal coordinate system.

b. Particle Size Distribution

(1) Quantitative determination of particle size distribution of fuel fragments in sufficient detail to construct distribution curve with good level of confidence.

(2) Sampling fuel in metric system at points 30, 20, 10, 5, and 1 mm; 750, 500, 250, 100, 50, 10, and 1 micron.

(3) Classifying fuels as to angularity, sphericity, 1/d, surface area, and density (fragment characterization).

(4) Qualitative determination of fragment size distribution of other engine components.

c. Mass Density Distribution of Debris

d. Two Dimensional Mapping of Debris

e. Weight and Size of Components Recovered

These data requirements are a combination of the collection of fundamental data and the analyses of the fundamental data to establish the entire post-operational destruct pattern. Sandia will instrument to acquire and analyze the fundamental data described above.

2. FIELD TEST REQUIREMENTS

The required fundamental data will be obtained by the use of the following instrumentation systems:

a. Air sampling of the airborne cloud.

b. Pressure measurements.

c. Photo resistive measurement of detonator fire and case breakup.

d. Fixed foam particle collectors.

e. Rotating foam particle collectors.

f. Photographic coverage.

g. Electric power requirements.

Each of the above will be discussed with respect to the coverage intended and the needed field construction support required.

In addition, to the above mentioned instrumentation systems the general test configuration 2.8, event firing and event timing 2.9 will be discussed.

Finally, the general requirements 2.10 will be discussed.

2.1 AIR SAMPLING

The air sampling array encircles the test vessel to prevent data loss even if a wind direction other than the normal is present. However, to be assured of air sampling success Sandia requests that the firing will occur only when the wind velocity is between 5 and 10 mph.

The latter requirement for specified limits on wind velocities makes it very desirable to have a small weather station located near the firing site. Sandia requests that a field weather station be available at the firing site.

Air sampling will be done at a 100-foot radius around ground zero. This net will consist of 24 air sampling devices suspended from a 1/2-inch diameter steel cable stretched between four poles. Figure 1 shows the air sampling array. Sandia requests that Aberdeen provide the materials and installations as indicated on Figure 1.

The installation shown in Figure 1 will be supplemented by Sandia furnished materials, such as pulleys at the 16 numbered locations.

The pulleys will be attached to the 1/2" steel cable and hemp rope will be used to raise and lower the air sampling devices.

2.2 PRESSURE MEASUREMENT

Pressure values will be obtained along a jet at 45° between jets and at 5° on either side of a jet. The only installation necessary for the installation of pressure transducers will be posts as shown in Figure 2.

2.3 PHOTO RESISTIVE MEASUREMENT OF DETONATOR FIRE & CASE BREAKUP

These two areas of instrumentation will be discussed together as they will be recorded on a single tape recorder.

The photo resistive measurement is a very small photo cell which will look at the flash from the externally mounted detonators (bridge wires) and the flash when the case ruptures. Each flash will be recorded as a voltage pulse on the tape recorder. The zero time and case break-up time will be used to calculate the velocity of the pressure wave.

2.4 FIXED FOAM PARTICLE COLLECTORS

These particle collection devices are located at 40-feet from ground zero and are intended to show the relative lack of debris in their particular locations. Figure 3 shows the location of the two fixed foam particle collectors and the structure needed for mounting.

Figure 4 shows the box construction needed to support the foam plastic. Sandia requests that Aberdeen provide both the materials and fabrication for the support structure and the boxes.

2.5 ROTATING FOAM PARTICLE COLLECTORS

Rotating foam particle collection devices are located as shown in Figure 5. The catchers, which are directly in line with the east and west jets, are mounted on a platform as shown in Figure 6. The other catchers are mounted on a platform as shown in Figure 7.

Figures 8 and 9 show the plywood boxes needed to support the foam plastic in front of the catchers.

These arrays of catchers will give velocity of particles as they arrive and the foam protection in front of the catchers will indicate the concentration of debris.

Sandia requests that Aberdeen fabricate the platforms shown in Figures 6 and 7, install them as shown in Figure 5, and fabricate the boxes shown in Figures 8 and 9.

2.6 PHOTOGRAPHIC COVERAGE

The photographic coverage for this destruct test will remain somewhat flexible and will be finalized at the actual time of camera placement. The camera sites shown will be the general location.

Figure 10 shows this general location for the cameras. The notes on this general layout are requests for the necessary site construction.

Sandia will supply the photographers and photographic equipment such as cable, timers, cameras, and tripods that will be necessary for the intended coverage.

Information requested is an early, detailed plan for the actual timing and firing of the event. Attached to this plan is a preliminary countdown procedure which gives timing requirements which will be necessary for proper operation of Sandia equipment.

2.7 ELECTRICAL POWER REQUIREMENTS

The power requirements for each area of instrumentation are shown in Figure 11 with the approximate location desired for the power generators. Adequate protection should be provided for these generators.

Sandia requests that Aberdeen supply and protect the electrical generators as shown in Figure 11. Further, the availability of power cables, their length, and the number of outlets should be furnished to Sandia in order that any remaining cable necessary can be acquired.

2.8 GENERAL TEST CONFIGURATION

This discussion will be split into two sections, (a) the field operation, and (b) the test hardware.

(a) Field Operation

The test vessel will be supported such that the geometric center of the core is 9.0 feet above the ground level.

The explosive charges will be fired from the test vessel end adjacent to the ground.

The support structure will be a frangible structure such that little or no radial containment is offered and minimum containment is offered in a longitudinal direction.

The test vessel will be placed in position on its stand and the explosive charges aligned with the 45° lines, measured from a line passing through ground zero and the center of the hard surface collection area. This line will be used as datum orientation and will be called "North Jet".

(b) Test Hardware

Each individual part of the test hardware will be weighed prior to assembly and each individual part will be identified by metal stamping, where possible, in a sufficient number of places to assure identification of broken pieces after test firing.

Further, the outside of the pressure vessel will be marked to identify the location of the explosive charges and the location of the numbered reflector segments and drums.

Generally speaking, all test hardware should resemble the actual propulsion reactor as closely as possible.

2.9 EVENT TIMING & FIRING

The event timing is very important and must be precise to assure photographic coverage. It will be necessary to have millisecond timing from at least 70 milliseconds prior to firing set pulse. Further, the total time from firing set pulse to detonator firing should not be greater than 5 microseconds. All four charges should fire within the 5 microseconds.

These requirements make it necessary to provide signals with millisecond accuracy from the firing point to the instrumentation points.

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Further, Sandia recommends that detonator cables from detonator to firing set be no longer than 40 feet.

2.10 GENERAL REQUIREMENTS

In addition to the specific materials, construction, and communications requested, there are other requirements which will be discussed.

The photography personnel will need a dark room for loading and removing film from the cameras.

Also, to assure good film coverage, a small quantity of pretest film will be exposed. This fill will be Anacochrome in 100' x 16 mm, 100' x 35 mm rolls, and black and white in a 9" width. It is desired to obtain 24-hour service for processing. The facility may be local or commercial. Sandia requests assistance from Aberdeen in establishing accessibility to a facility.

Space on the helicopters is requested for overall photographic coverage of the event.

Sandia requests that the following materials and support be available for site use:

1000 linear feet of 2" x 4" lumber

500 linear feet of 4" x 4" lumber

50 4' x 8' sheets of 3/4" plywood

1 crane for installing equipment on the platforms

1 Cherry Picker (70' to 75' reach)

4 construction type personnel for general carpentry work, with normal tools

10 20-foot lengths of 1-1/2" galvanized steel pipe

Sand and equipment for filling sand bags. Estimated quantity of sand is about 150 cubic yards.

3. POST TEST REQUIREMENTS

The area will be declared safe to enter by both the Explosives Safety Officer and the Radiation Safety Team prior to any other personnel entry.

After the area has been declared safe to enter, the collection of samples will proceed. Sandia requests that no object be moved or removed

until the complete debris area is mapped and all materials located to the satisfaction of both Aberdeen and Sandia.

The particle collection devices and the particles from the collection areas will be removed and packaged to assure the greatest collection of particles and debris.

After the small particle collection is complete, the entire test area will be mapped identifying the location, size, and weight of each item of debris.

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APPENDIX I

References

Feasibility Test of a Weapon Launched Destruct System for a Nuclear Rocket Engine. Report No. DPS-1060.

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APPENDIX II - Test Directive

SPACE NUCLEAR PROPULSION OFFICE

CLEVELAND EXTENSION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

21000 BROOKPARK ROAD, CLEVELAND 35, OHIO

In reply refer
to: TSB:HPS

May 4, 1965

Commanding Officer
U.S. Army
Test & Evaluation Command
Aberdeen Proving Ground, Maryland

Attention: AMSTE-NB

Ref.(a): SNPO-C TWX dated April 7, 1965 to H.A. Bechtol, D&PS

Dear Sir:

It is requested that a destruct test of a simulated full scale NERVA reactor be conducted on or about June 15, 1965, as provided for by SNPO-C DPR SNC-7. This test is necessary for the development of a destruct model needed by the NERVA Program, and to provide basic countermeasure safety information applicable to nuclear rocket propulsion systems.

The test should be instrumented to allow for the measurement of particle size and weight distribution, velocity, and direction resulting from the destruct event. The test planning should allow for continued assistance to the Atomic Energy Commission's contractor, The Sandia Corporation, to insure their useful participation in the test.

The planning should be consistent with agreements resulting from the meetings held at APG on March 5, March 23, April 6, and April 29, and with the Sandia Corporation in Albuquerque, N.M., on March 30. The explosive loaded projectiles for the test are to be supplied by the Ammunition Engineering Directorate, Picatinny Arsenal. The firing sequence and mechanism should be subject to the joint concurrence of Aberdeen Proving Ground D&PS, Picatinny Arsenal AED, and Sandia Corporation.

May 4, 1965

The test plan for the test should be submitted to SNPO-C in sufficient time to allow for a review prior to the test date.

The data reduction, analysis, and final test report should be completed and submitted to SNPO-C by August 12, 1965.

Very truly yours,

L. C. Corrington
Assistant Chief for
Technical Operations

HPS:lm
cc: H.A. Bechtol, APG
R. Holwager, APG

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APPENDIX III

COUNTDOWN PROCEDURE

A systems check will be performed at T-24 hours using the following procedure.

Communication check Check generator gas & oil Start generator Check generator output Air sampling checkout and adjustment Camera adjustment and loading and run Rotating devices timing check Rotating devices run check Pressure calibration check	T-4 hrs.
Clear area and establish road blocks	T-15 min.
Head count all personnel and location of personnel	T-10 min.
Timing tone (all communication nets) (accurate to 1 MS)	T-5 min.
Timing tone	T-4 min.
Timing tone	T-3 min.
Timing tone	T-2 min.
Timing tone (1 MS accuracy)	T-1 min.
Start catcher motors	T-30 sec.
Start catcher timing system	T-30 sec.
Timing tone	T-10 sec.
Air sampling start	T-10 sec.
Press recorder run	T-10 sec.
Helicopter cameras start	T-10 sec.
Continuous timing count on all communication nets and timing tone	From T-10 sec. To T-0 sec.

Countdown Procedure

Camera start (on timer)	
Millicans	T-4 sec.
Aerial cameras	T-4 sec.
Fastax	T-300 to 1000 ms
Dynafax	T-50 ms
Hycam	T-50 ms
Firing tone	T-0
High speed cameras stop	T+10 sec.
Stop catcher motors	T+30 sec.
Stop catcher timing system	T+30 sec.
Press recorder stop	T+30 sec.
Air sampling stop	T+2 min.
Other camera stop	T+2 min.
Explosive safety & radiation safety area check	T+5 min.
Start debris analyses	T+10 min.

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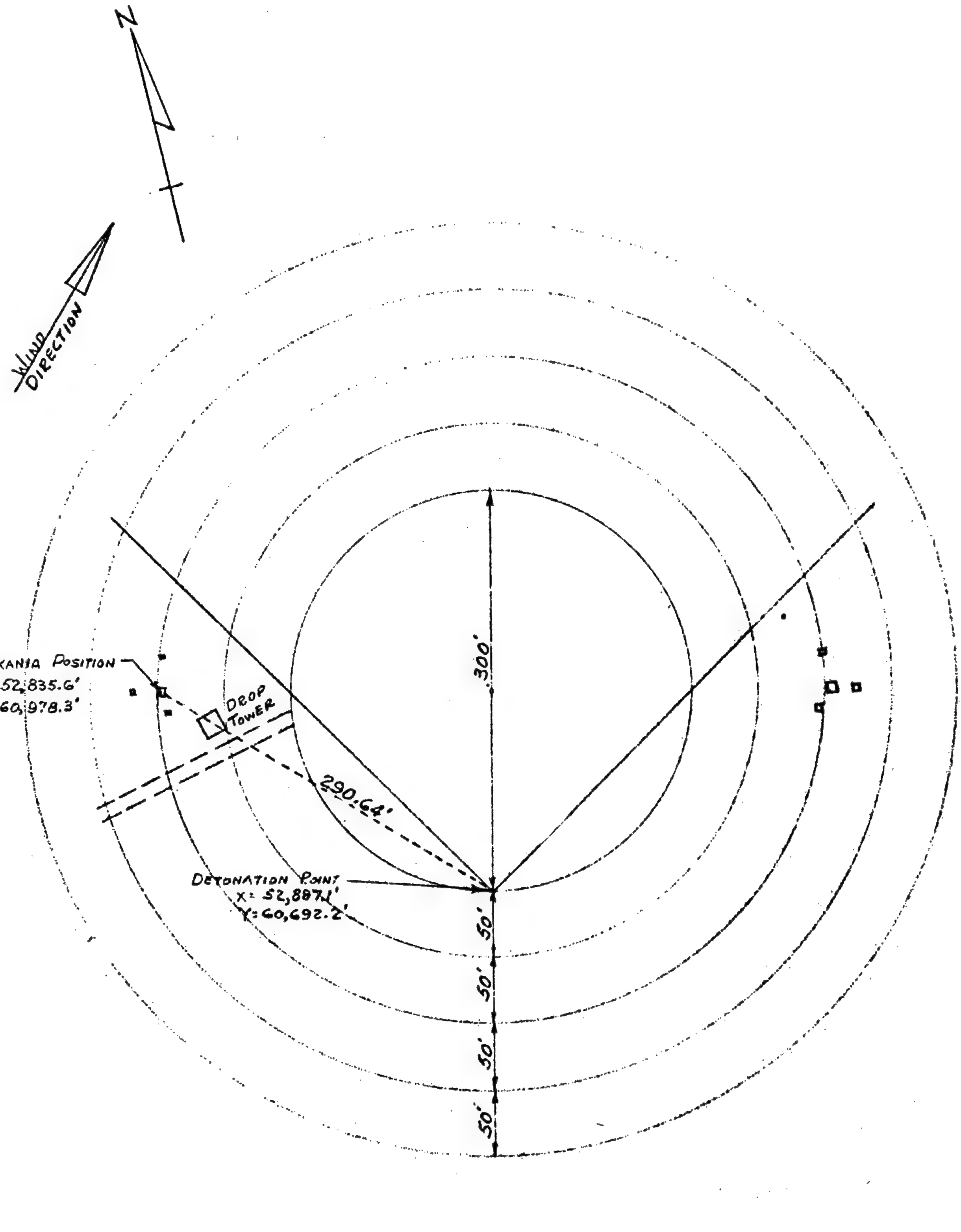
APPENDIX IV

Attachements & Figures



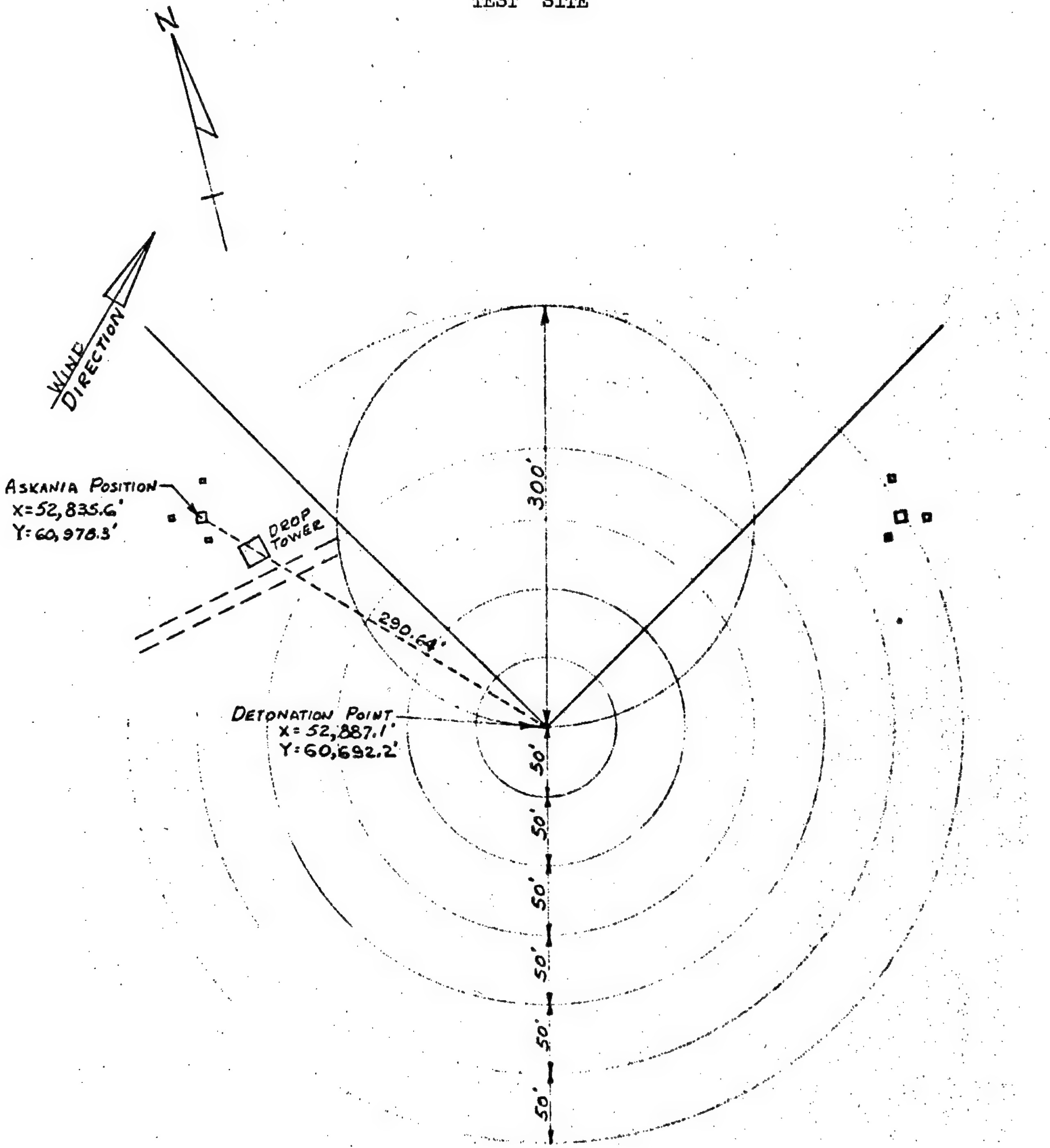
IV - 1

SCALE 1" = 100'

ATTACHMENT NO. 1

COPY COPY

TEST SITE



IV - 2

SCALE 1"=100'

ATTACHMENT NO. 2

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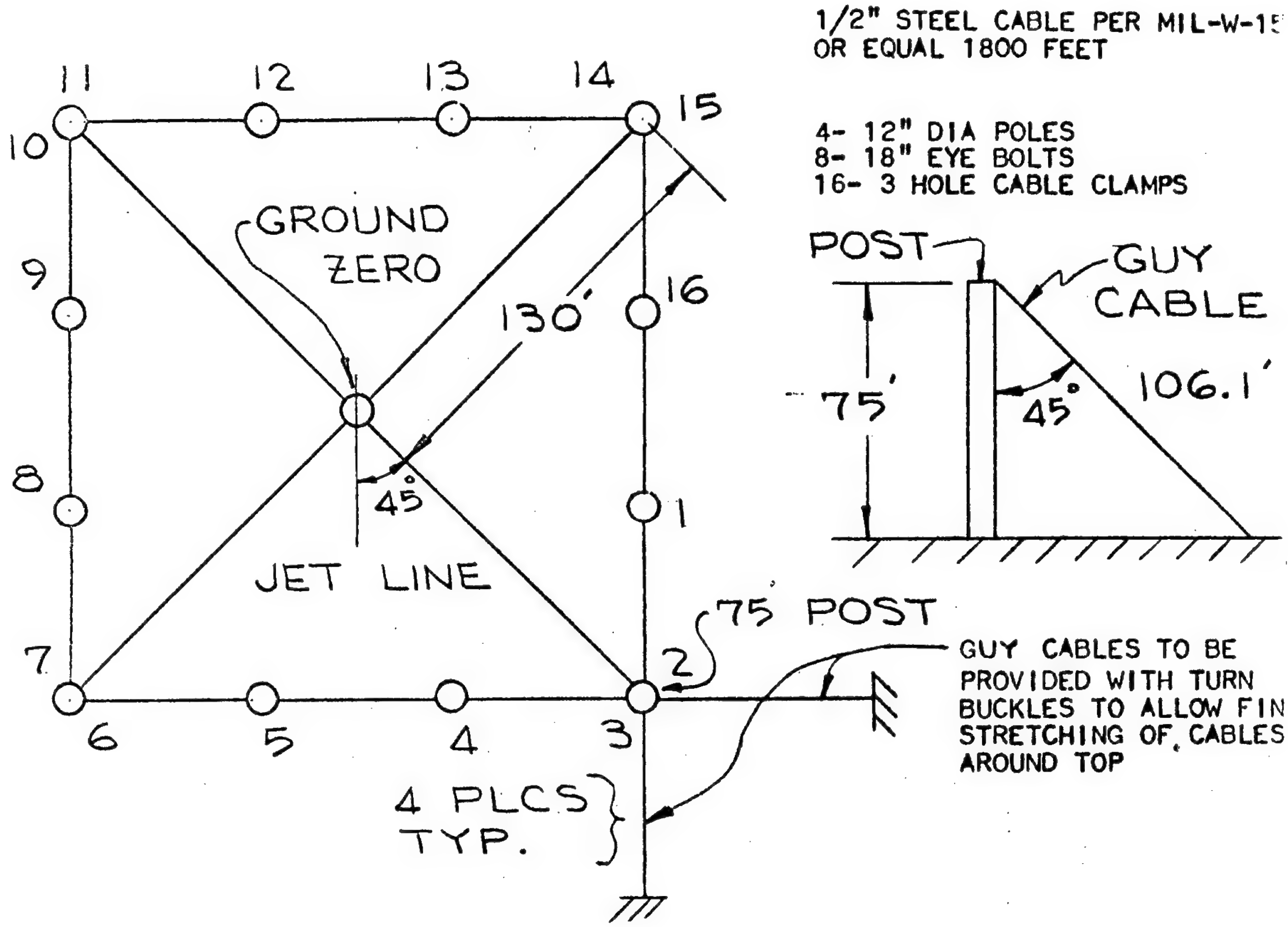
AIR SAMPLING



SANDIA WILL ATTACH PULLEYS AT POINTS NUMBERED 1 THRU 16 PRIOR TO THE ACTUAL STRETCHING OF THE CABLE FROM POLE TO POLE

FIGURE 1

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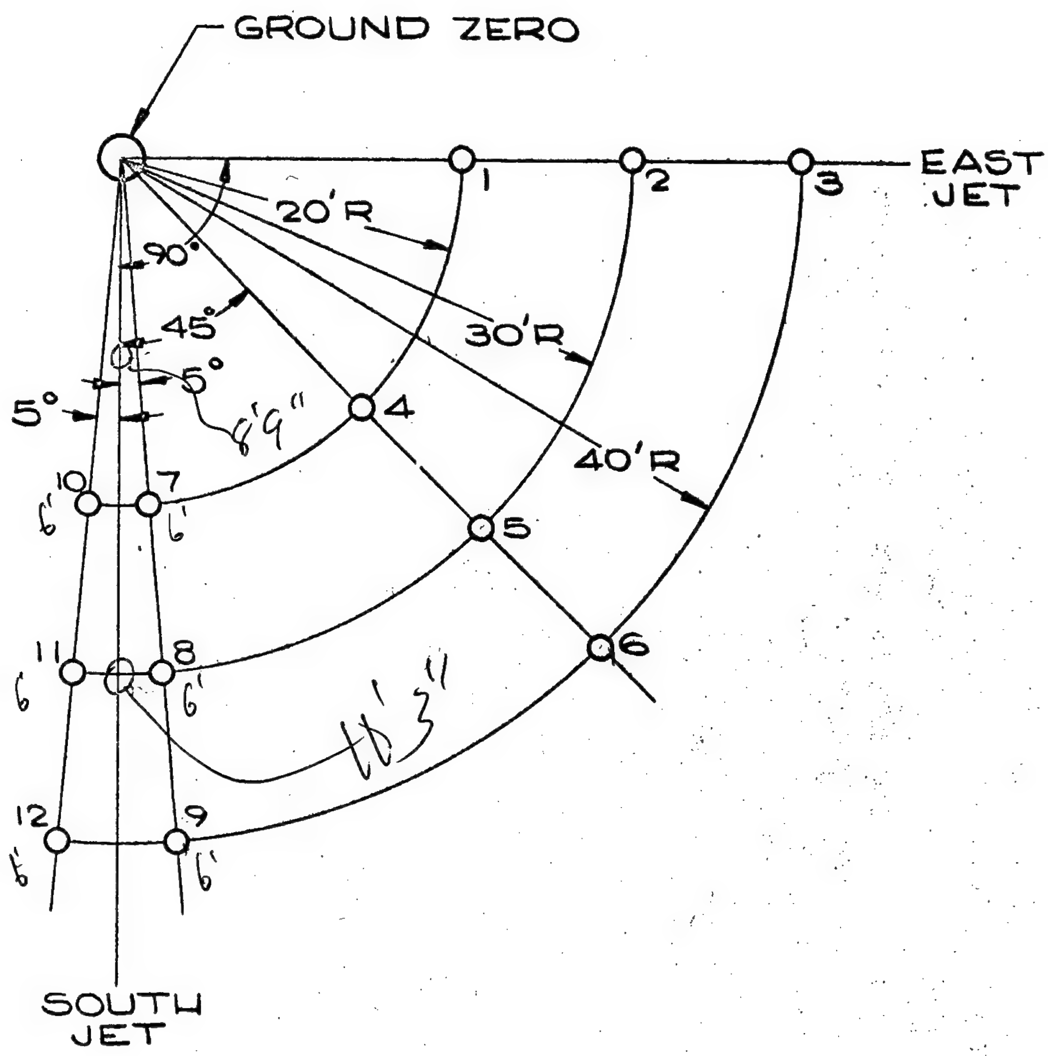
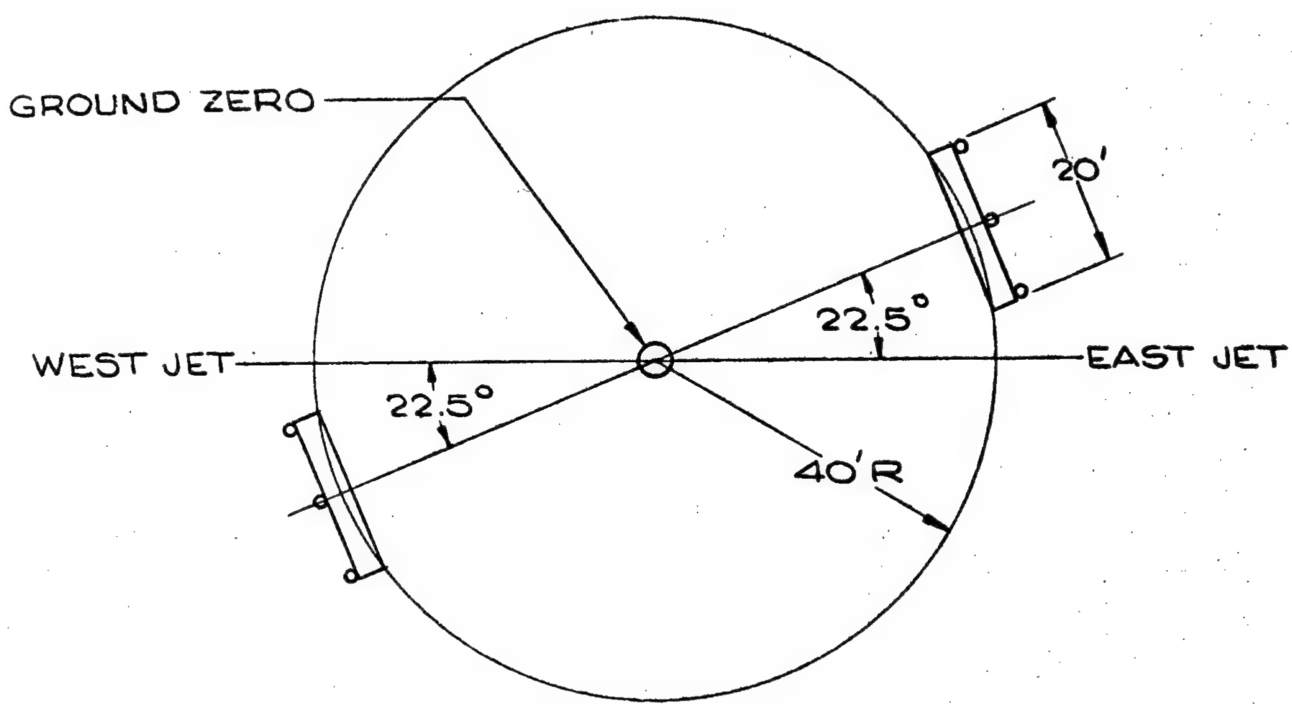
PRESSURE MEASUREMENT

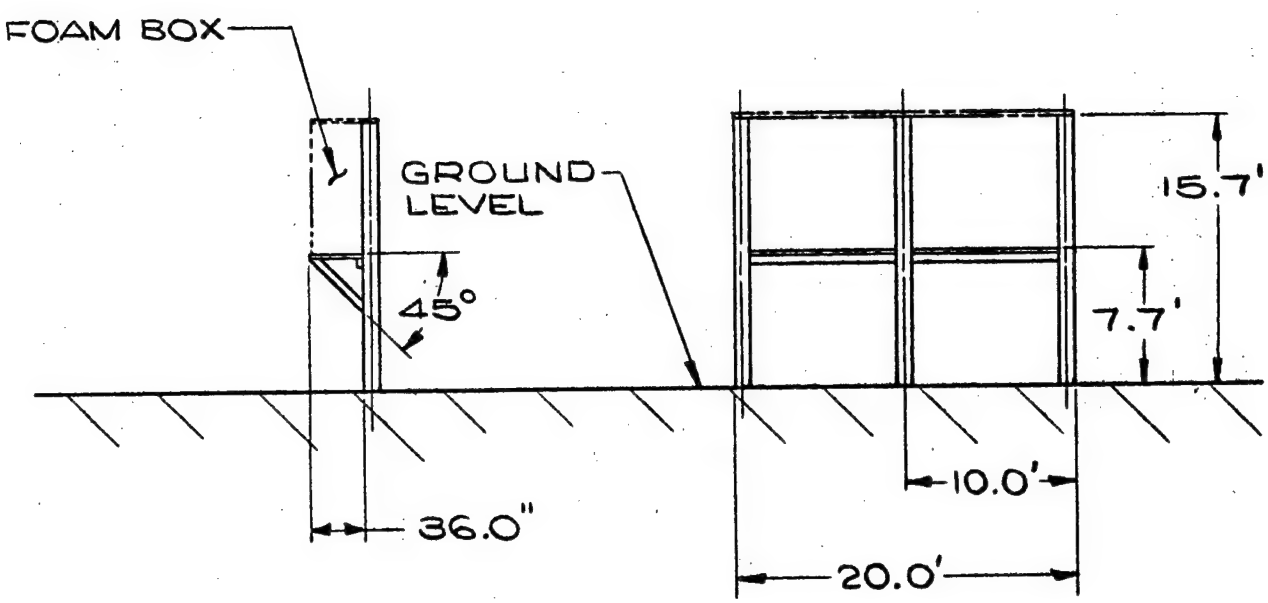


AT EACH NUMBERED LOCATION SET 1 2X4 POST WITH 6 FEET ABOVE GROUND.

FIXED FOAM INSTALLATION



SET THREE POSTS 8" TO 10" DIA. AT 15.7' ABOVE GROUND AT TWO LOCATIONS-
POSTS TO HAVE SHELF AS SHOWN BELOW



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.FIXED FOAM BOX

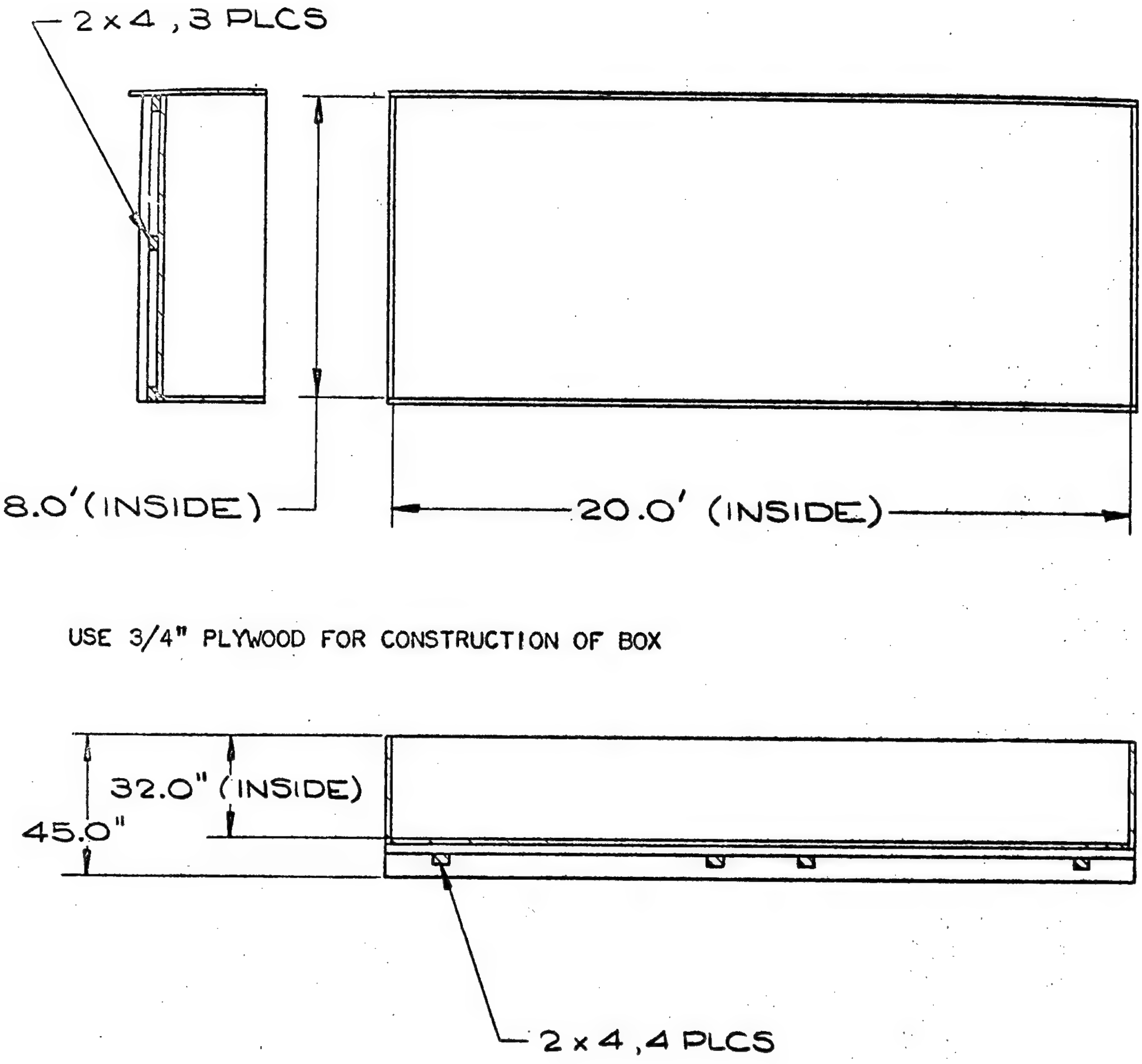

FIGURE 4 2 REQUIRED

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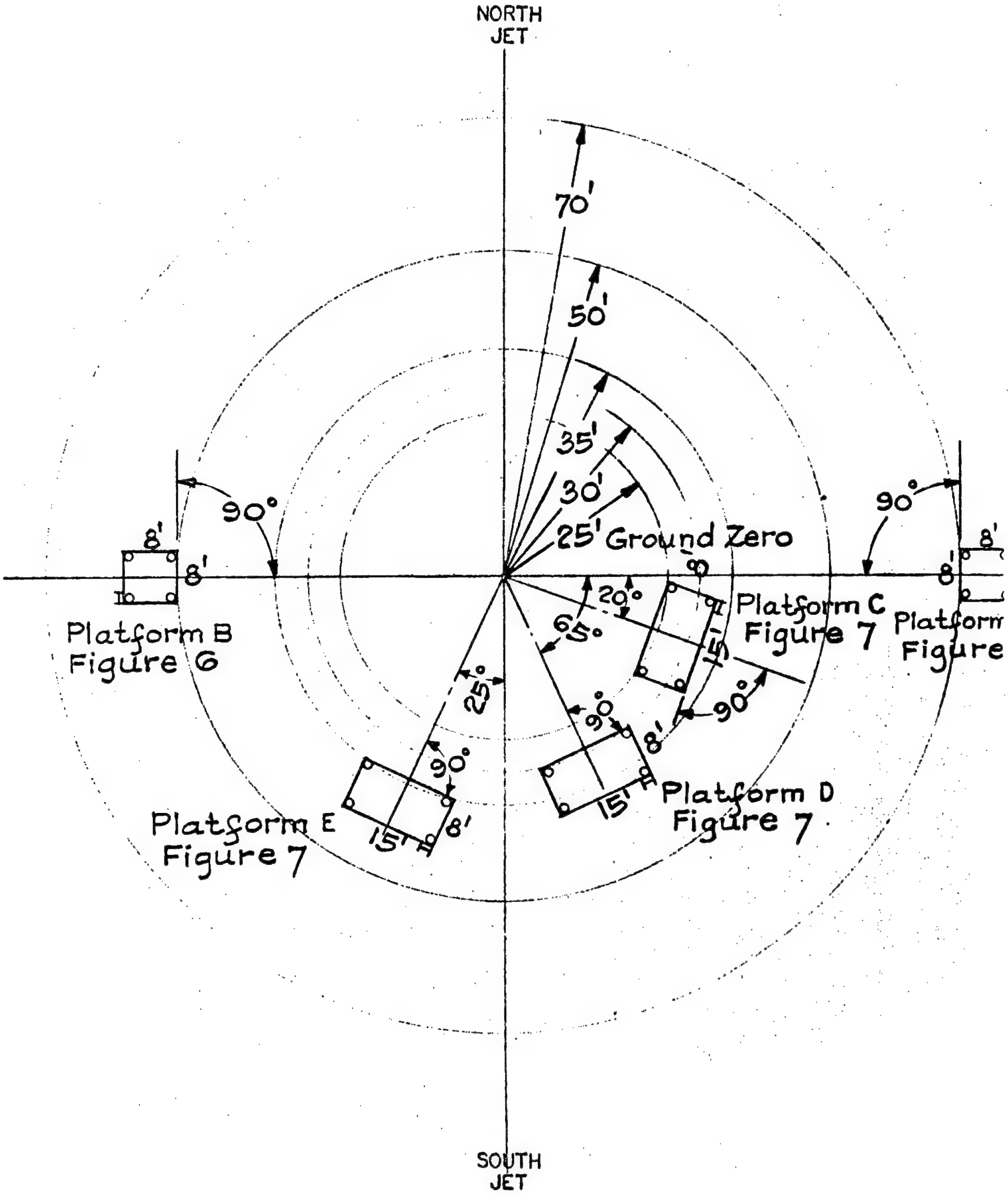
ROTATING FOAM PARTICLE COLLECTOR INSTALLATION



IV - 7

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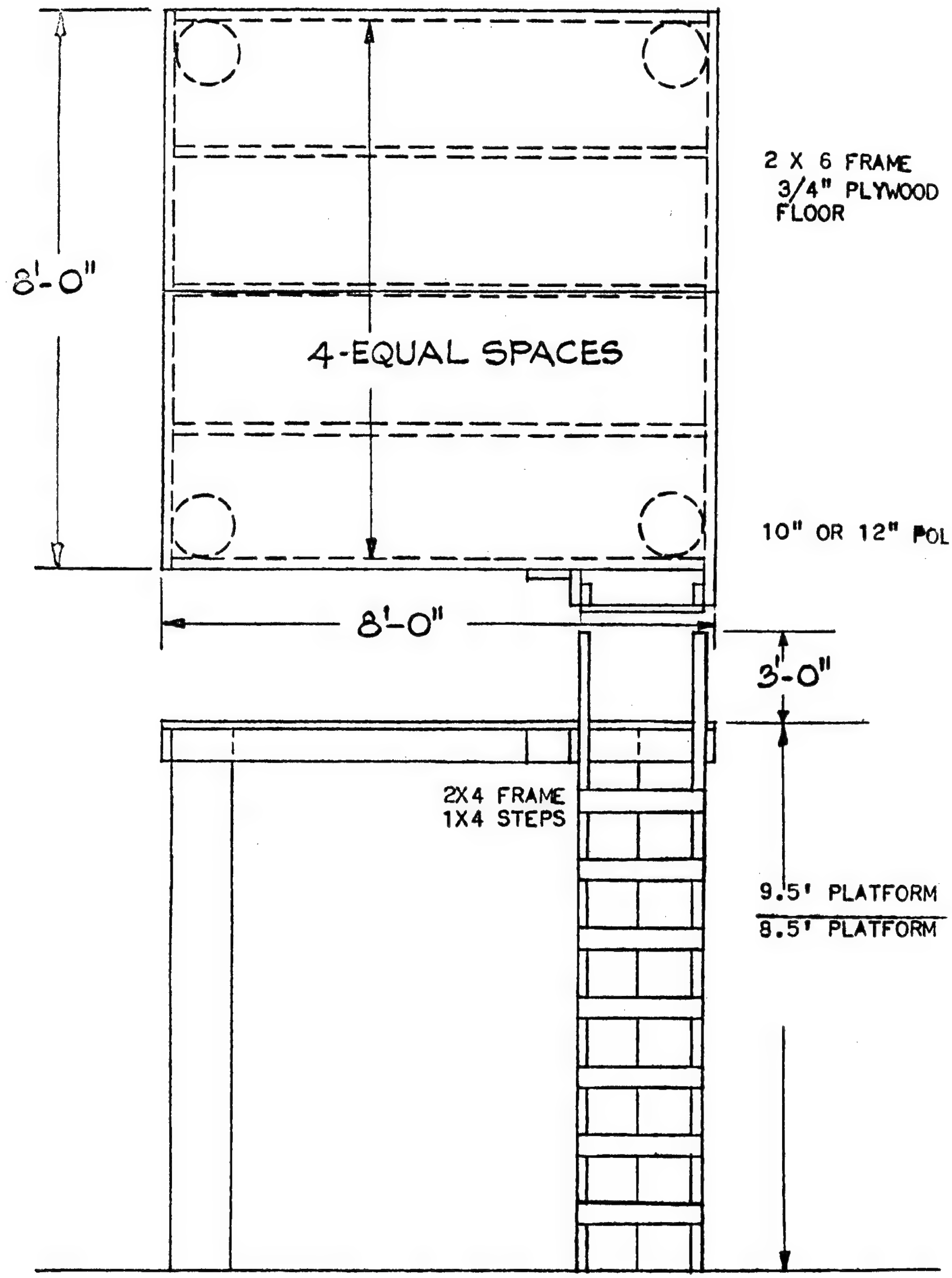
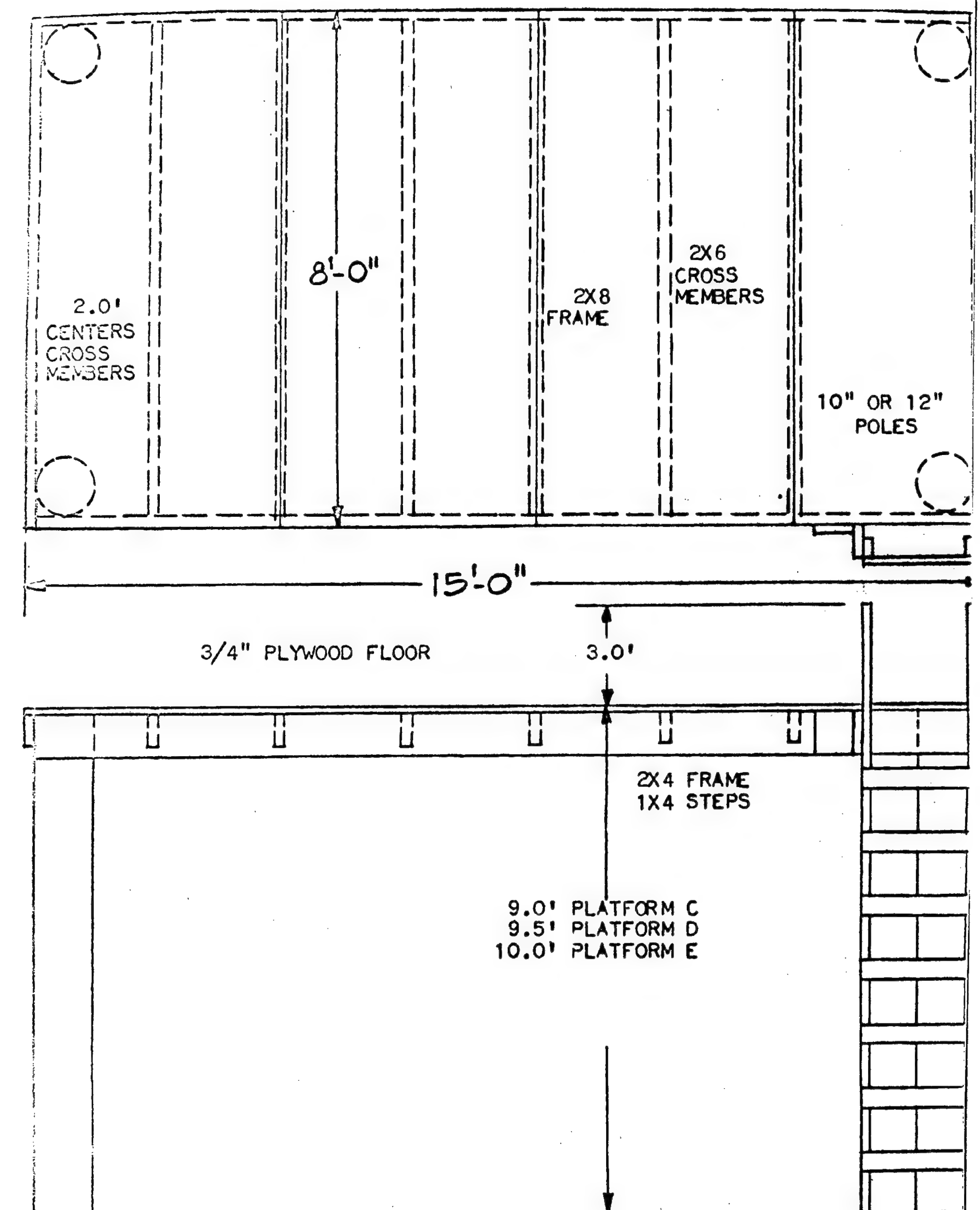
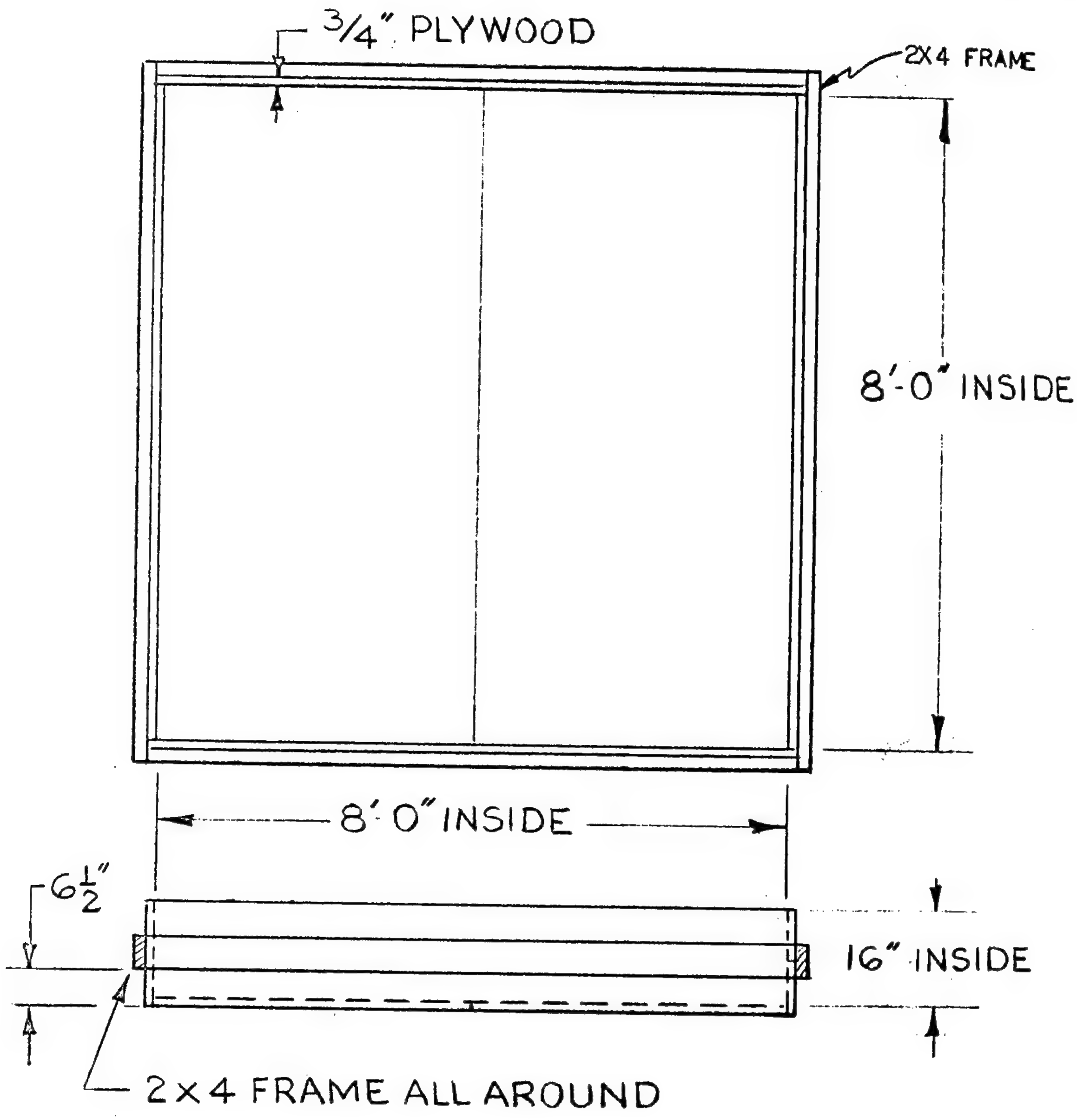
PLATFORM FOR CATCHERS AT POINTS
A AND B



PLATFORM FOR CATCHERS
AT POINT C,D, AND E.



FOAM HOLDERS - PLATFORMS
A & B

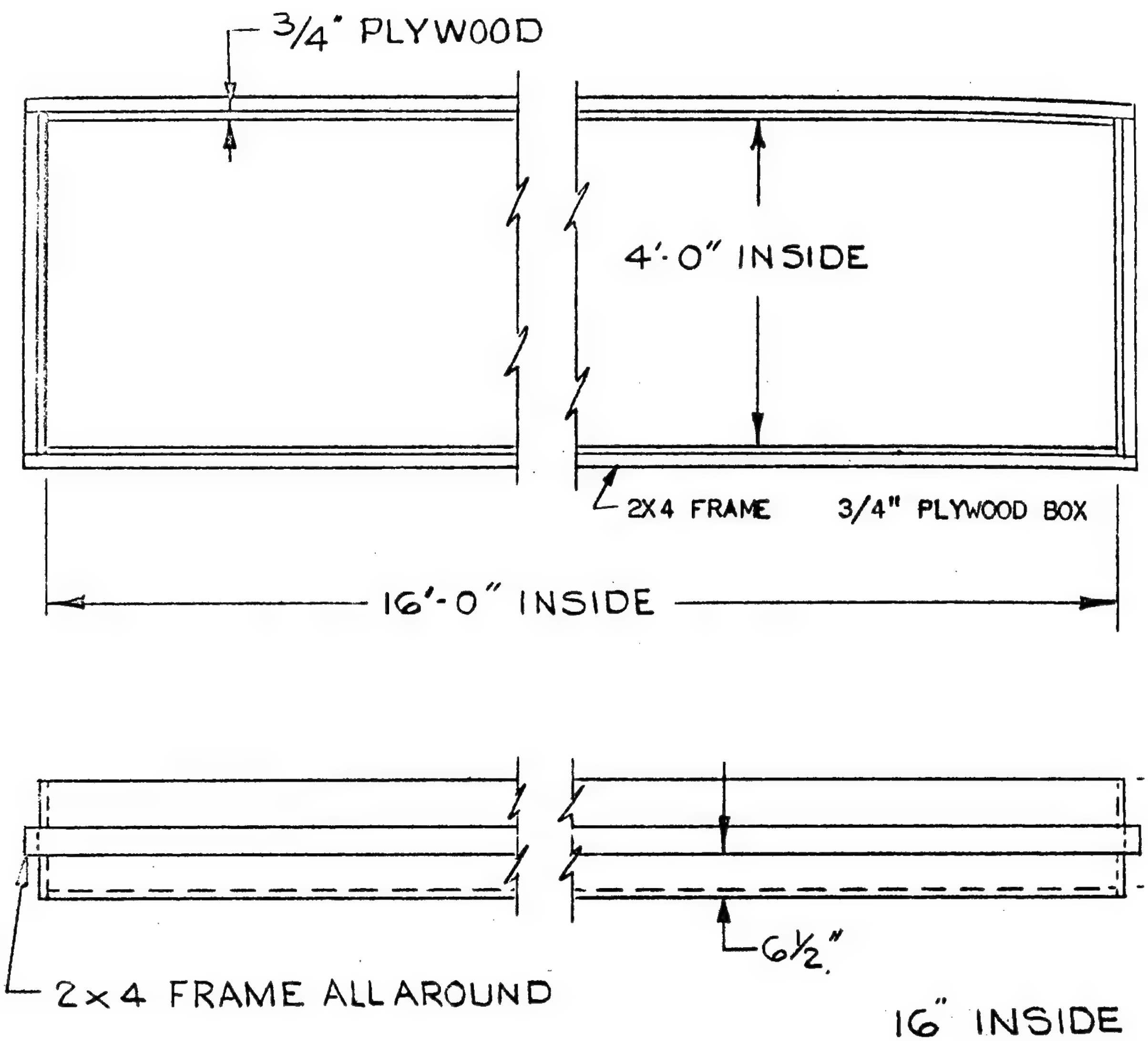


IV - 10
FIGURE 8

2 REQUIRED

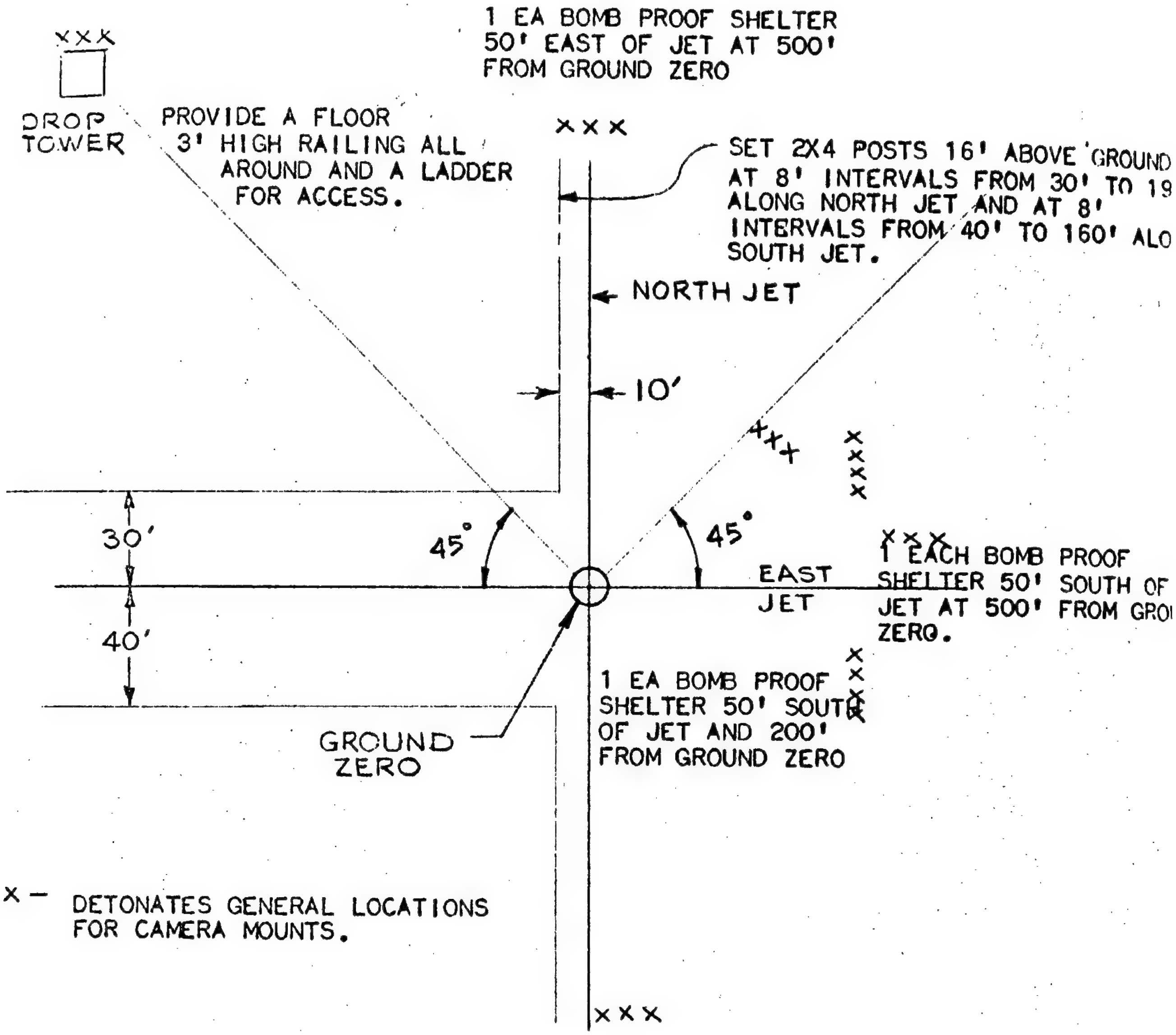
COPY

FOAM HOLDERS - PLATFORMS
C, D, AND E



IV - 11

FIGURE 9



PROVIDE SAND FOR FILLING SAND BAGS TO BE USED FOR CABLE AND CAMERA PROTECTION.

DISTANCE MARKERS WILL BE PLACED ALONG 8 EQUALLY SPACED LINES ORIGINATING AT GROUND ZERO. DISTANCE WILL BE MARKED AT 20 FOOT INTERVALS FOR 200 FEET AND THEN AT 50 FOOT INTERVALS TO 500 FEET.

FIGURE 10

COPY COPY

ELECTRICAL POWER LOCATIONS

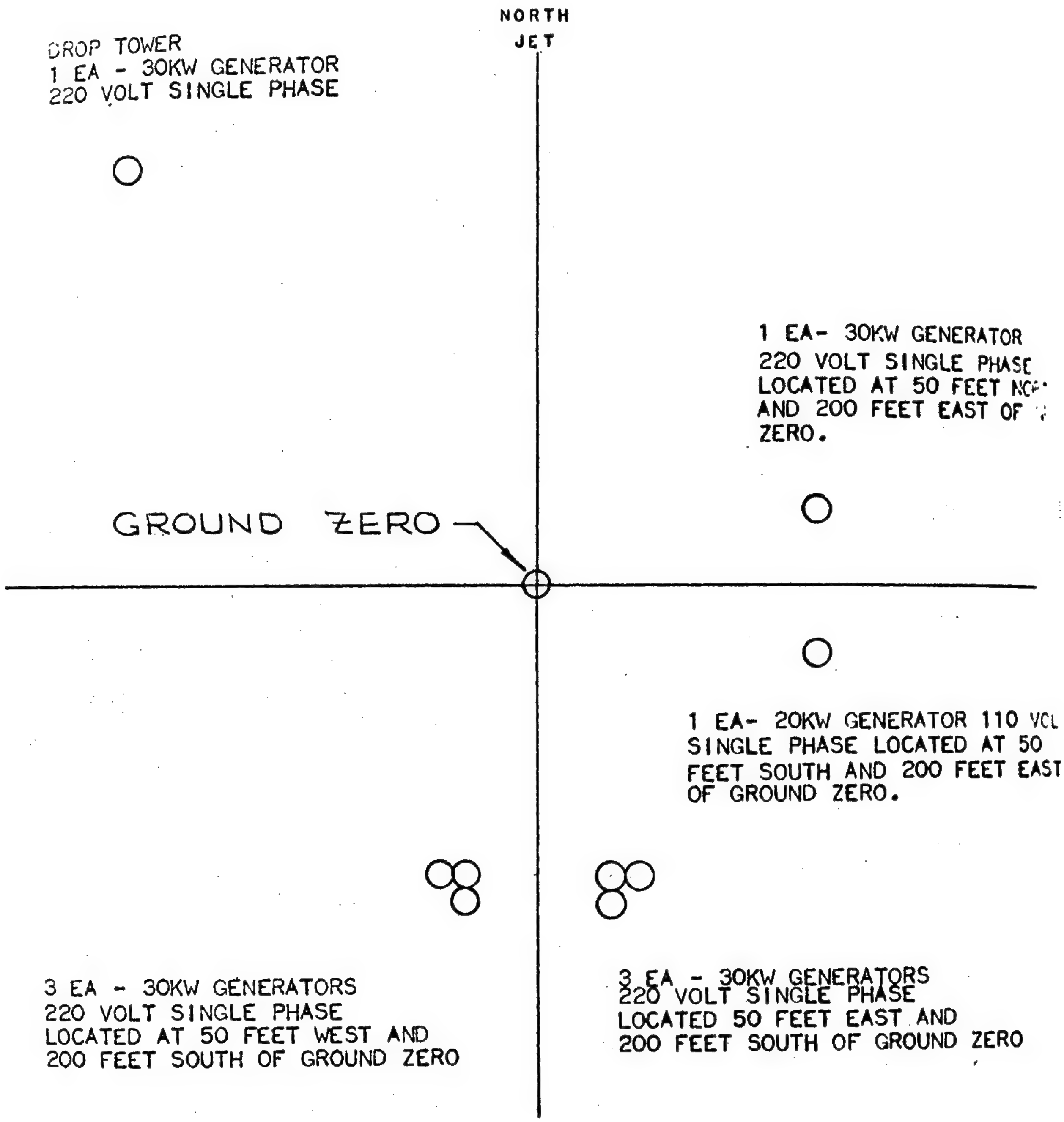


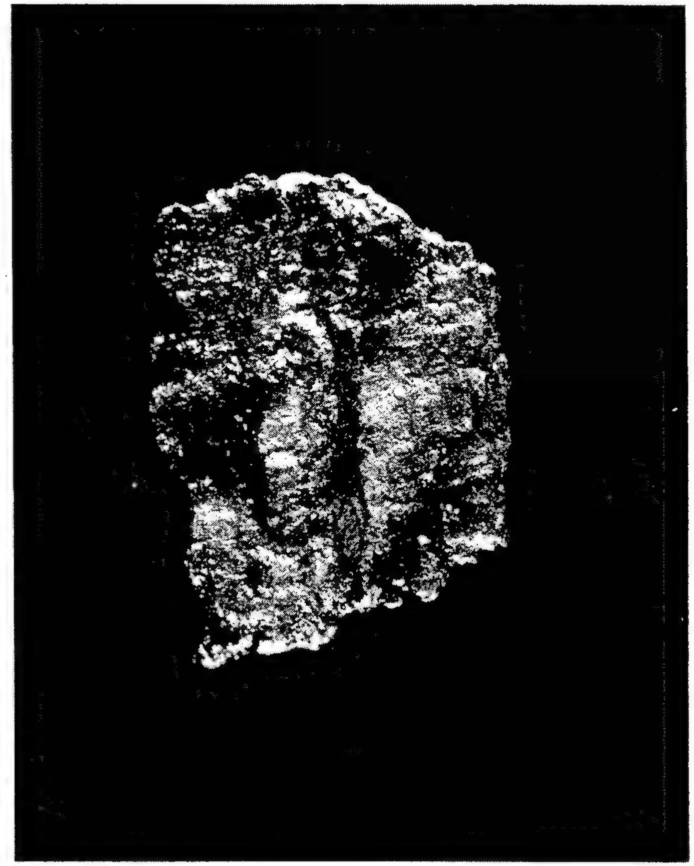
FIGURE 11

APPENDIX B

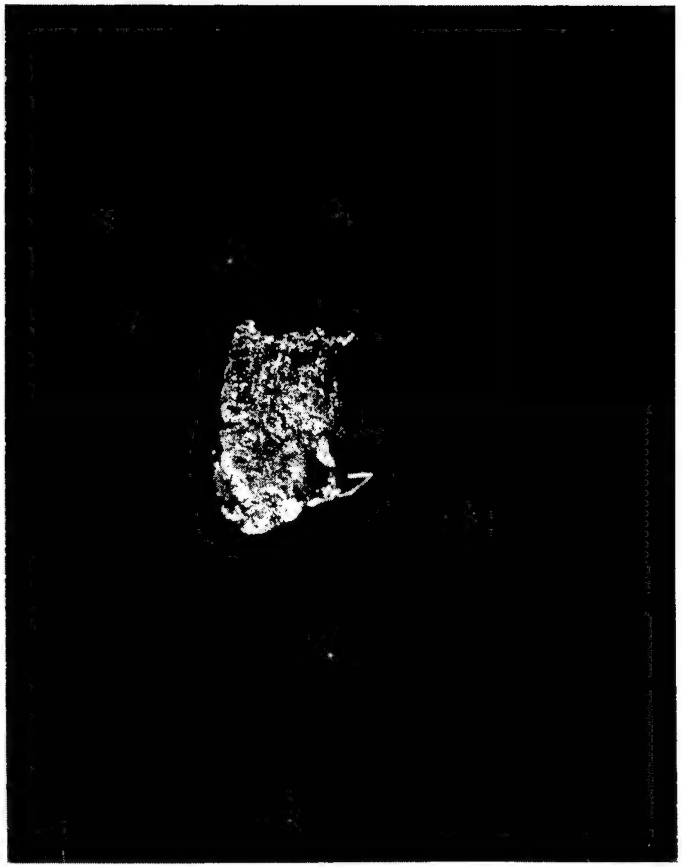
PHOTOS OF ROTATING POLYSTYRENE COLLECTED PARTICLES

The photos in this appendix are illustrations of the particles collected in the velocity devices. The illustrations are identified by number which refers to the tabulation on pages 57 and 58, where the velocity and mass for each particle are tabulated.

Photograph Number 1
Magnification 10X

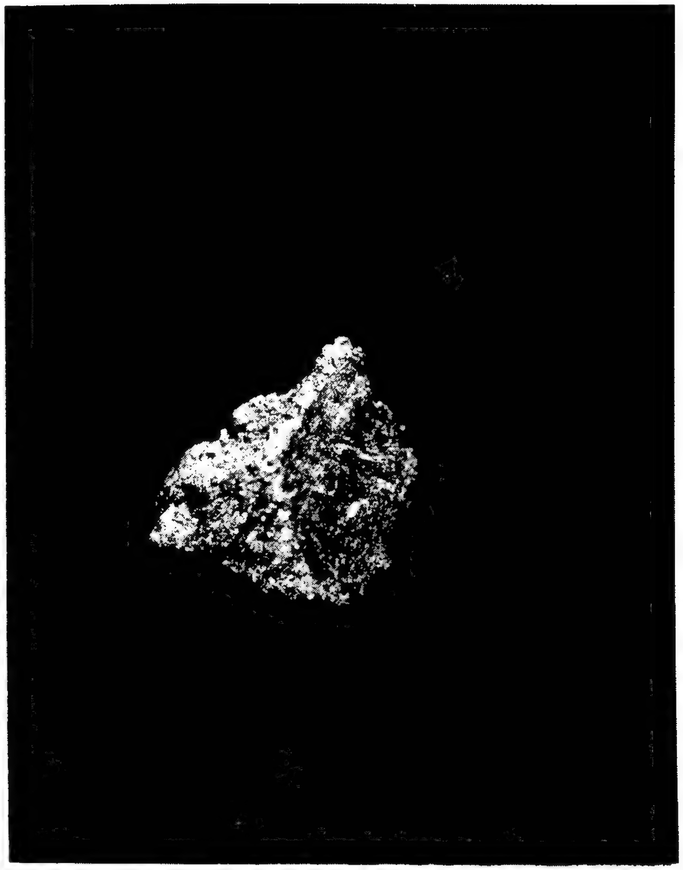


Photograph Number 2
Magnification 10X

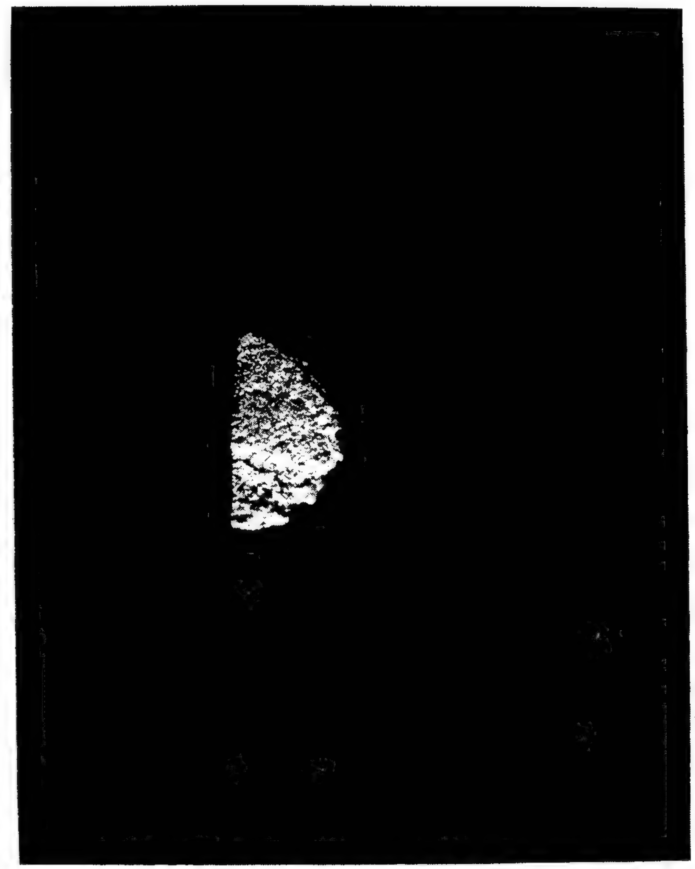


Photograph Number 3
Magnification 10X

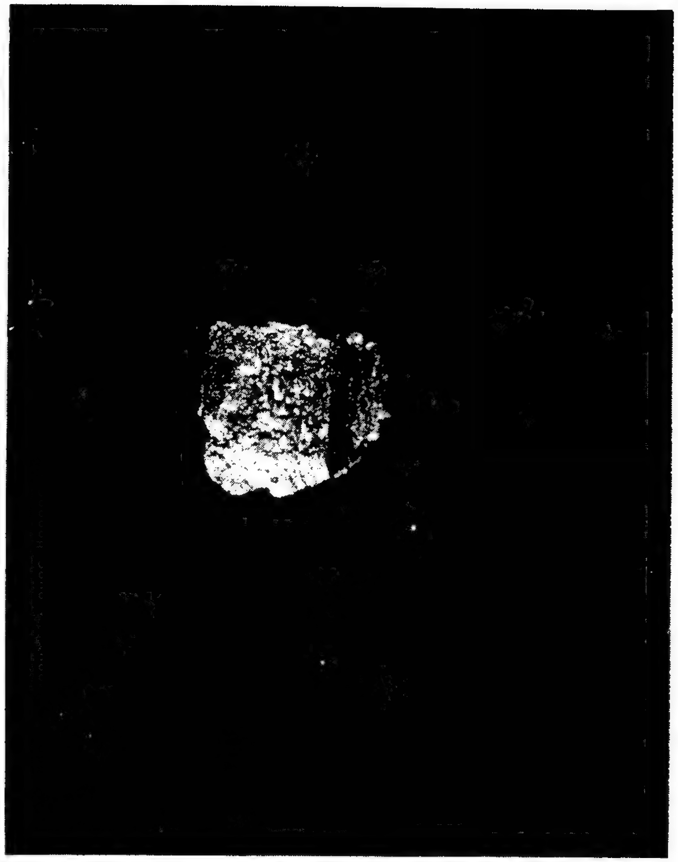
Photograph Number 4
Magnification 4X



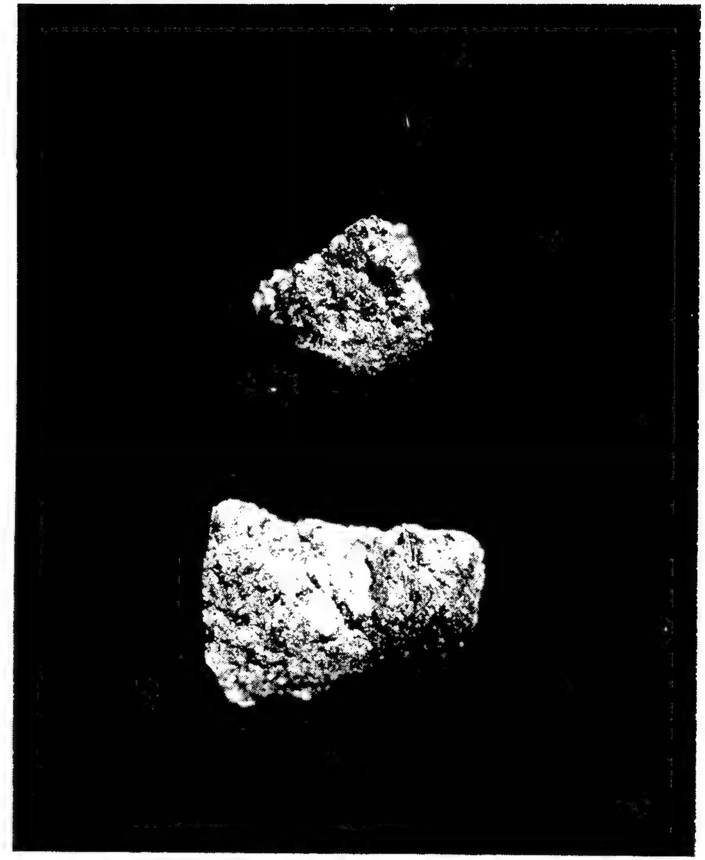
Photograph Number 5
Magnification 10X



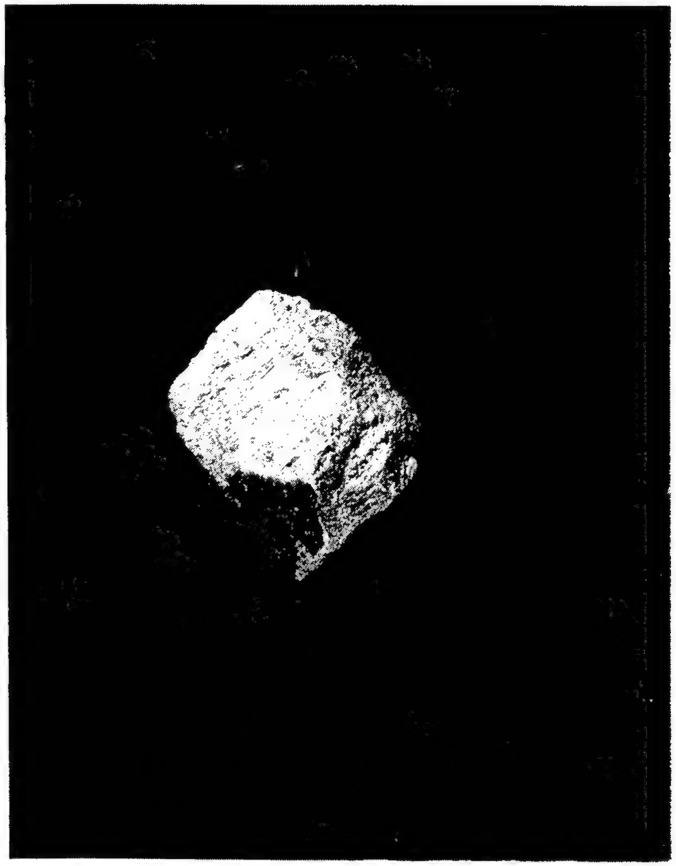
Photograph Number 6
Magnification 10X



Photograph Number 7
Magnification 10X



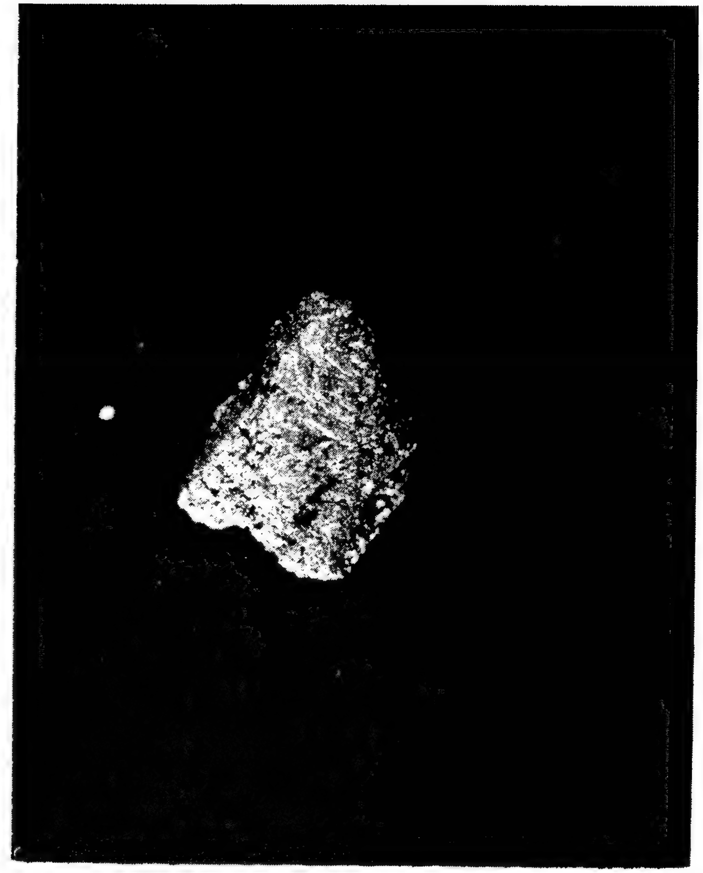
Photograph Number 8
Magnification 10X



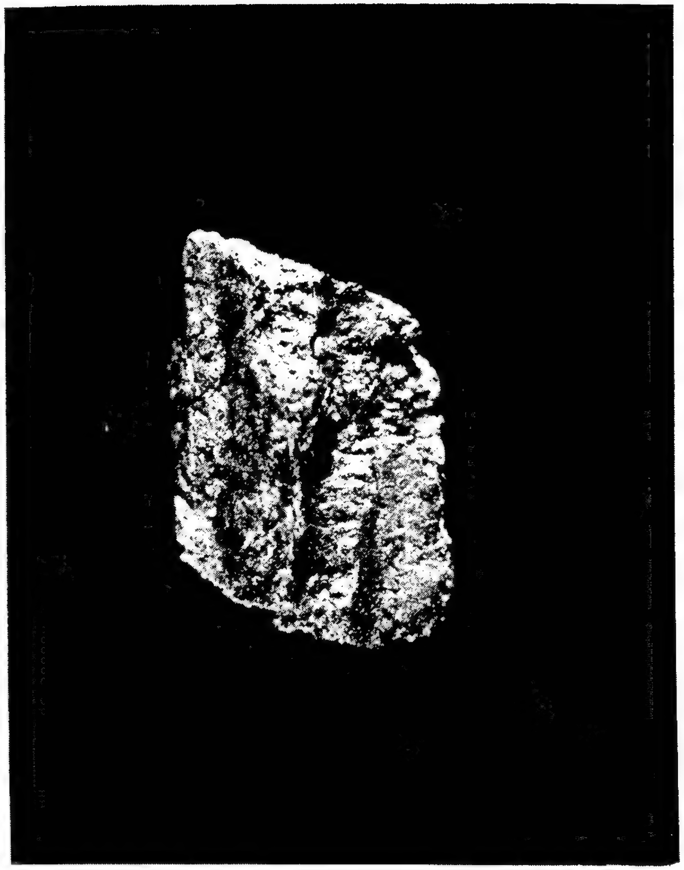
Photograph Number 9
Magnification 4X

Photograph Number 10
Magnification 4X

Photograph Number 11
Magnification 10X

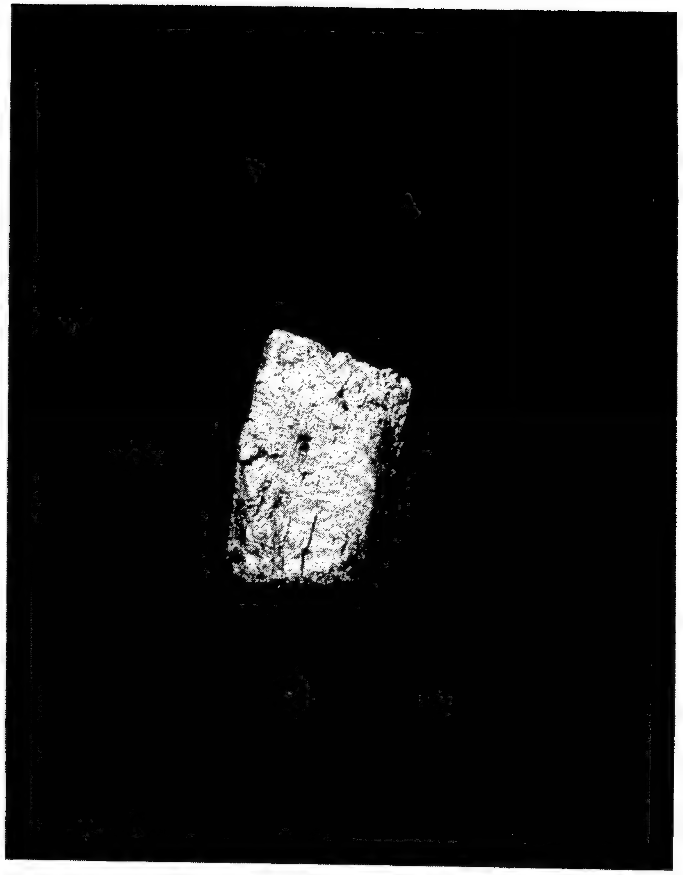


Photograph Number 12
Magnification 10X

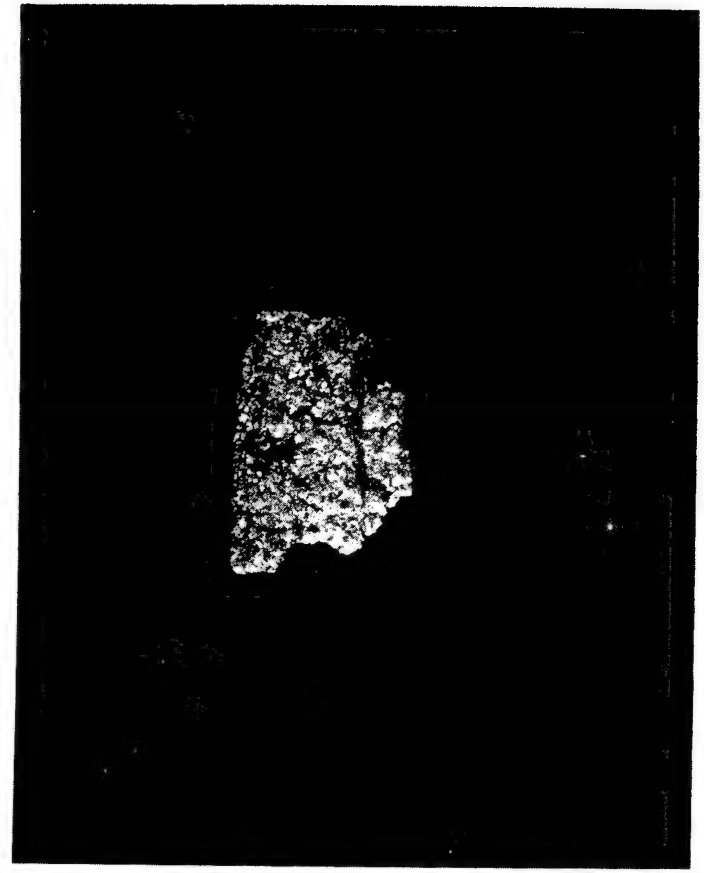


Photograph Number 13
Magnification 10X

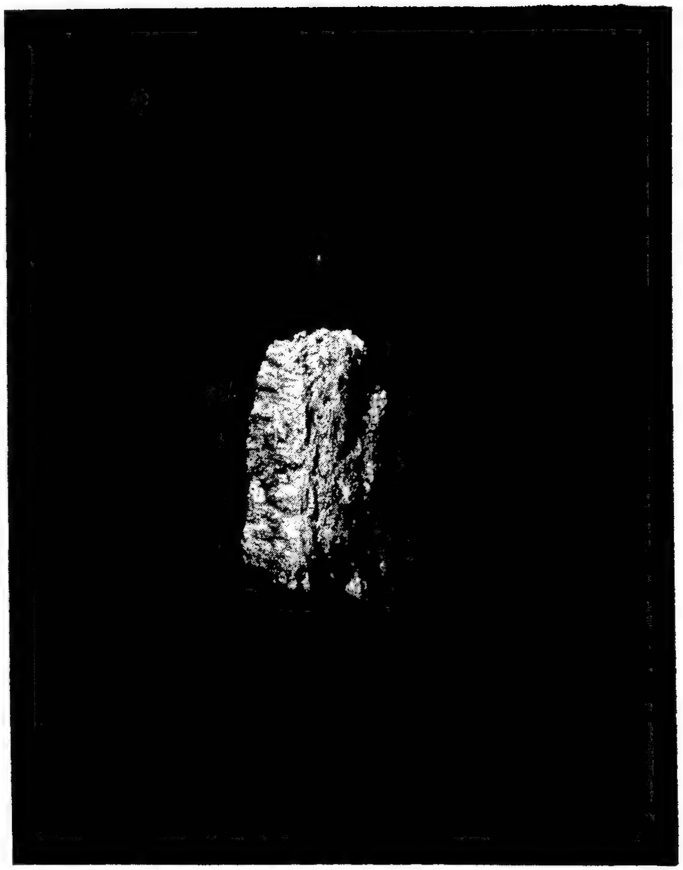
Photograph Number 14
Magnification 10X



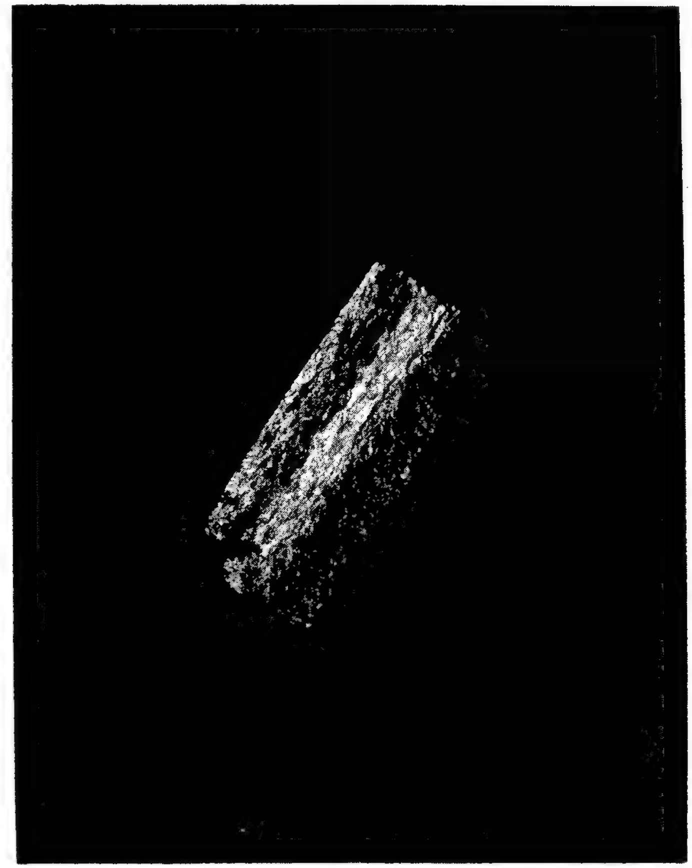
Photograph Number 15
Magnification 4X



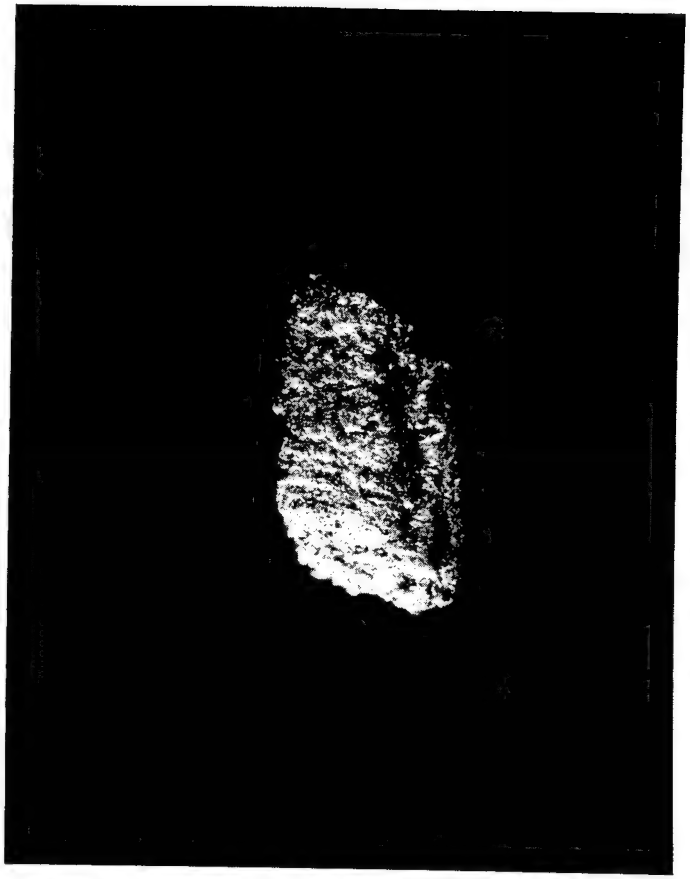
Photograph Number 16
Magnification 10X



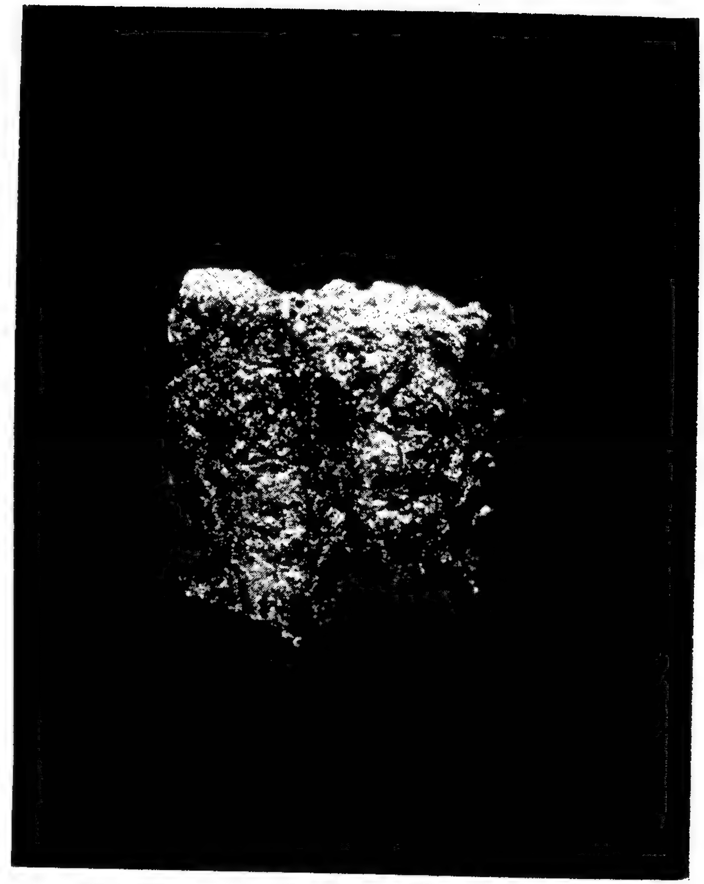
Photograph Number 17
Magnification 4X



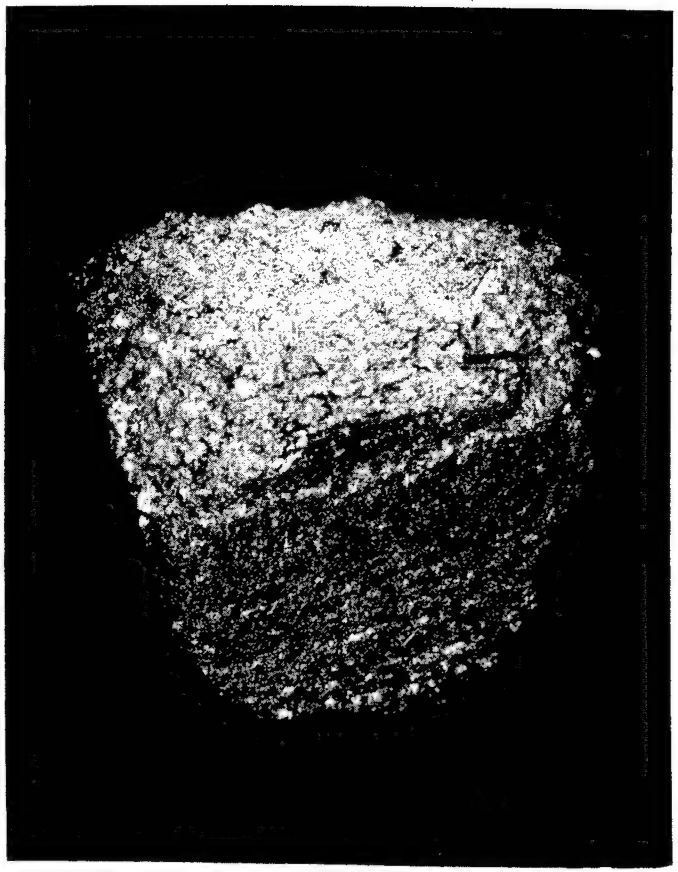
Photograph Number 18
Magnification 4X



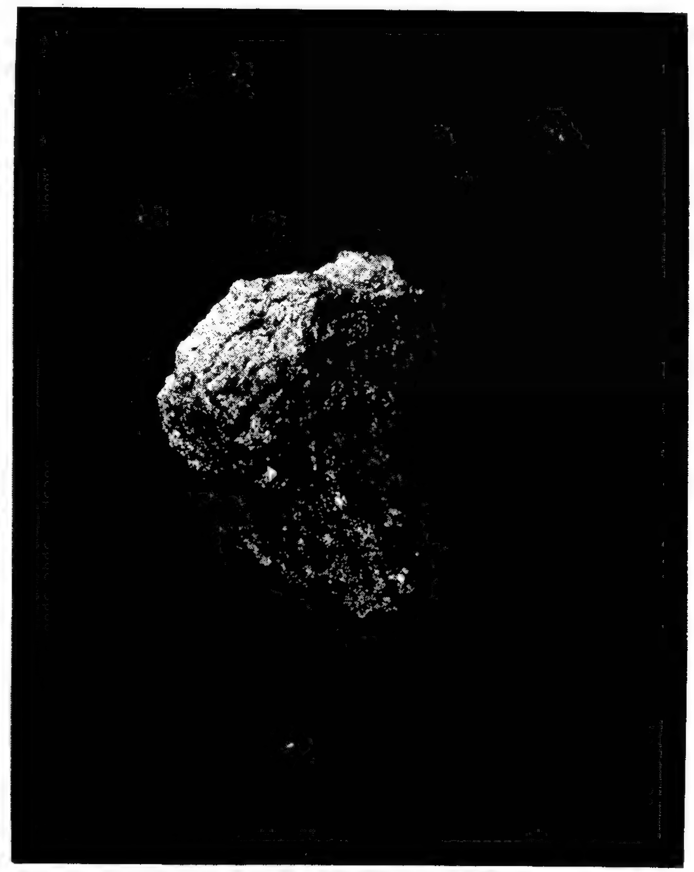
Photograph Number 19
Magnification 10X



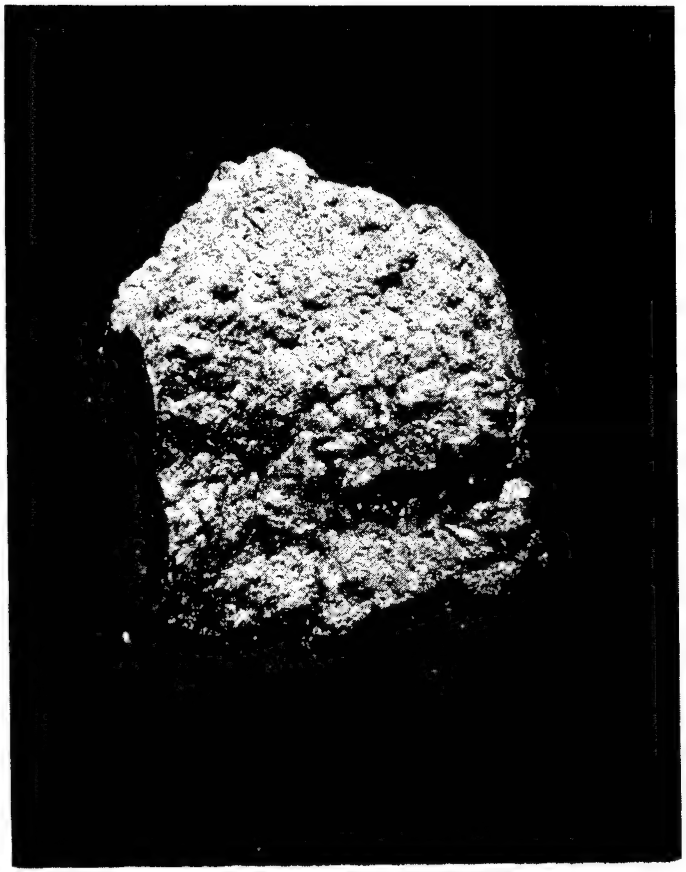
Photograph Number 20
Magnification 10X



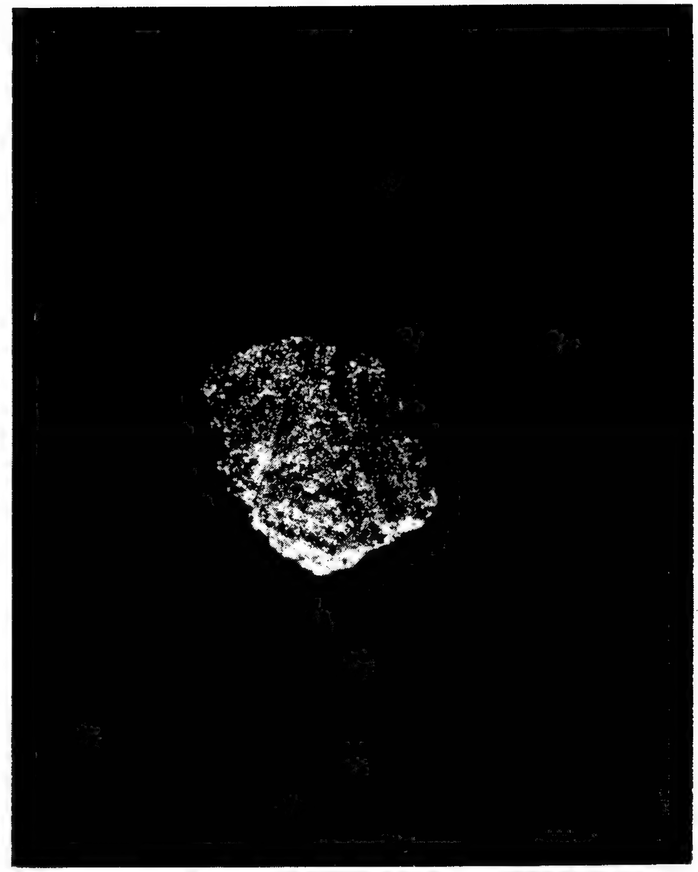
Photograph Number 21
Magnification 4X



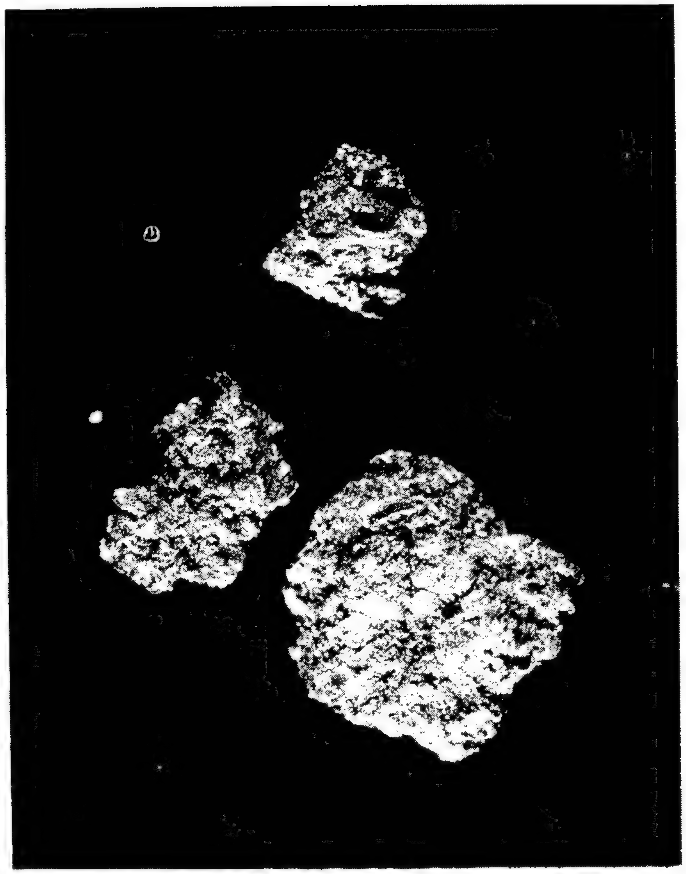
Photograph Number 22
Magnification 4X



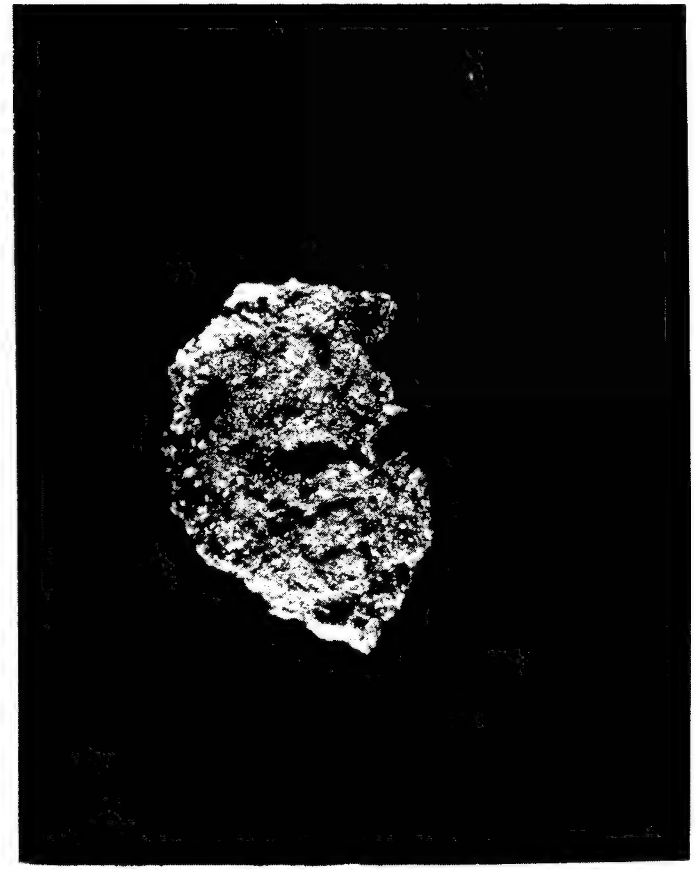
Photograph Number 23
Magnification 4X



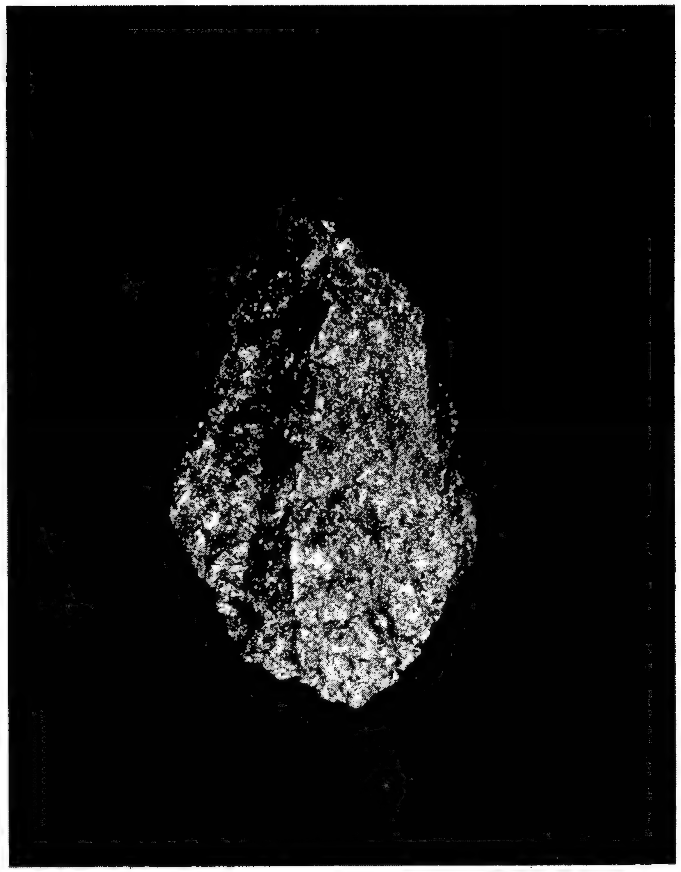
Photograph Number 24
Magnification 10X



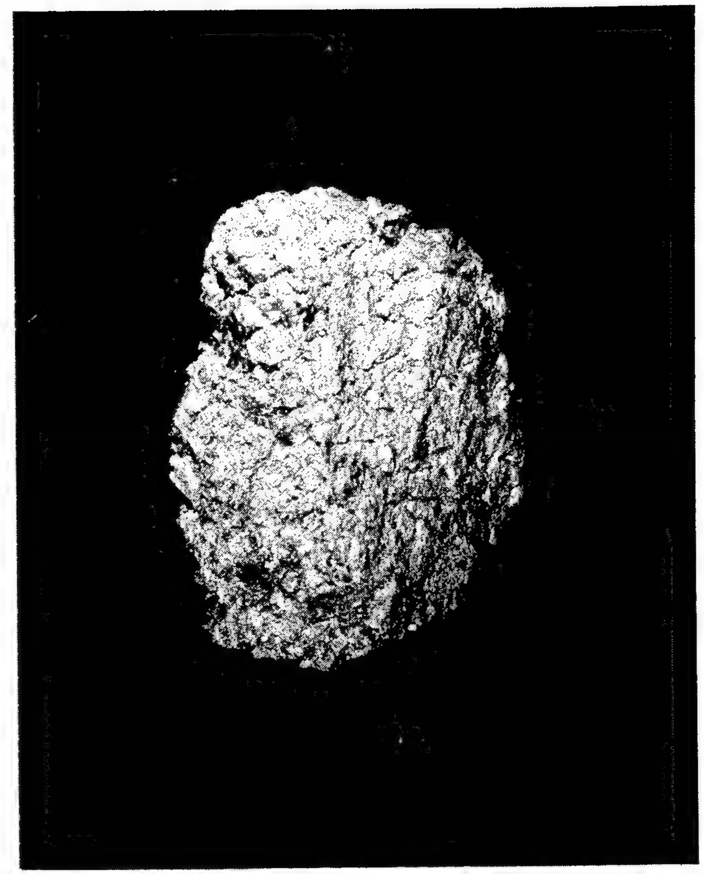
Photograph Number 25
Magnification 10X



Photograph Number 26
Magnification 10X



Photograph Number 27
Magnification 4X

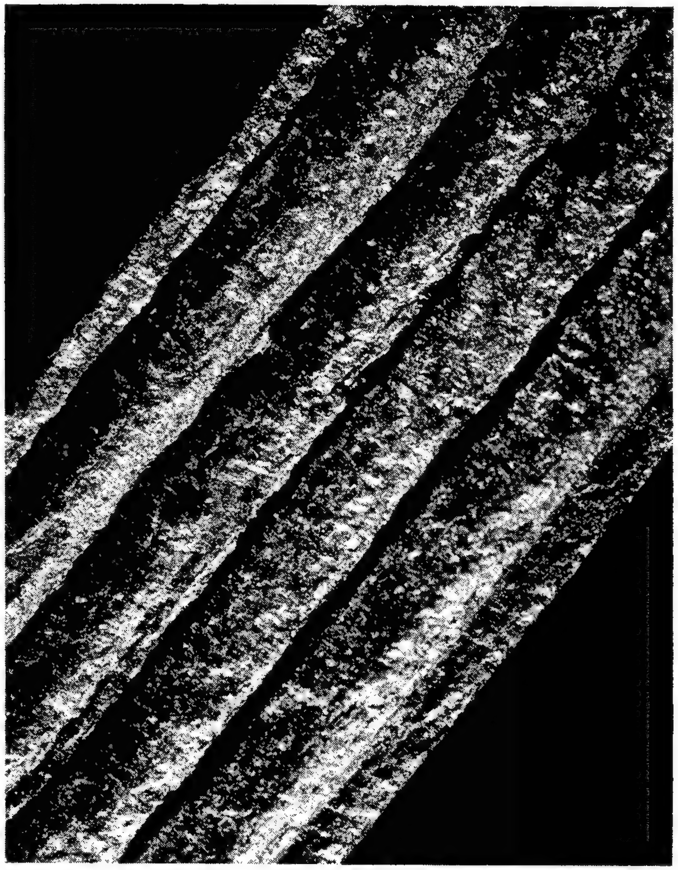


Photograph Number 28
Magnification 4X

APPENDIX C

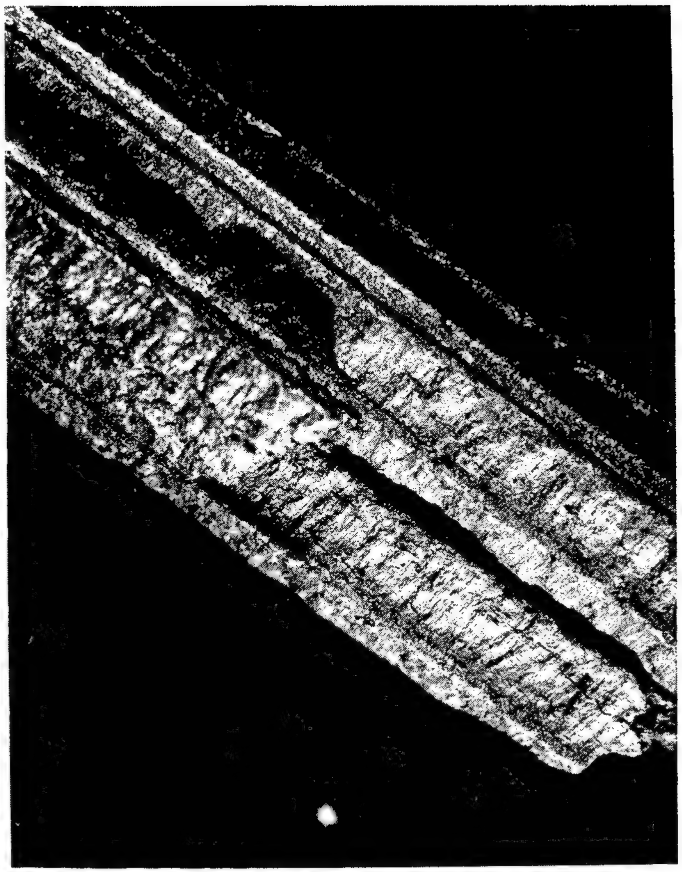
PHOTOS OF REPRESENTATIVE PARTICLES FROM EACH TYLER SCREEN SIZE

The illustrations in this appendix are representative of the particles collected on a specific screen size. The illustrations are arranged from the minimum size screen to the maximum size screen used to grade the graphite debris collected during the destruct test.

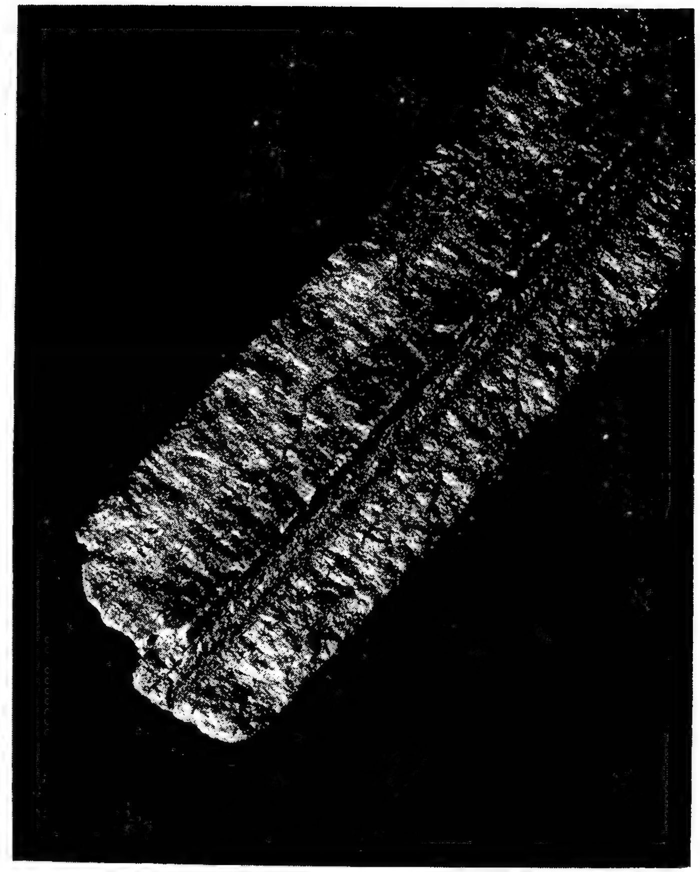


Particle Size: 26.9 mm
Magnification: 4X

Particle Size: 19 mm
Magnification: 4X



Particle Size: 13.5 mm
Magnification: 4X



Particle Size: 9.51 mm
Magnification: 4X

Particle Size: 6.73 mm
Magnification: 4X

Particle Size: 4.76 mm
Magnification: 4X

Particle Size: 3.36 mm
Magnification: 4X

Particle Size: 2.38 mm
Magnification: 4X

Particle Size: 1.41 mm
Magnification: 4X

Particle Size: 1.00 mm
Magnification: 4X

Particle Size: 0.841 mm
Magnification: 4X

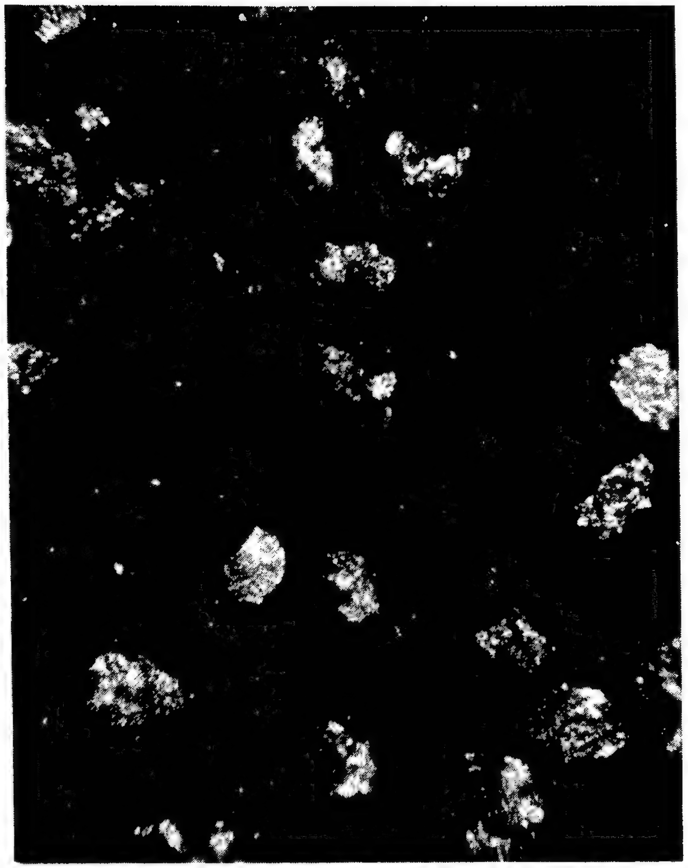
Particle Size: 0.595 mm
Magnification: 4X

Particle Size: 0.420 mm
Magnification: 63X

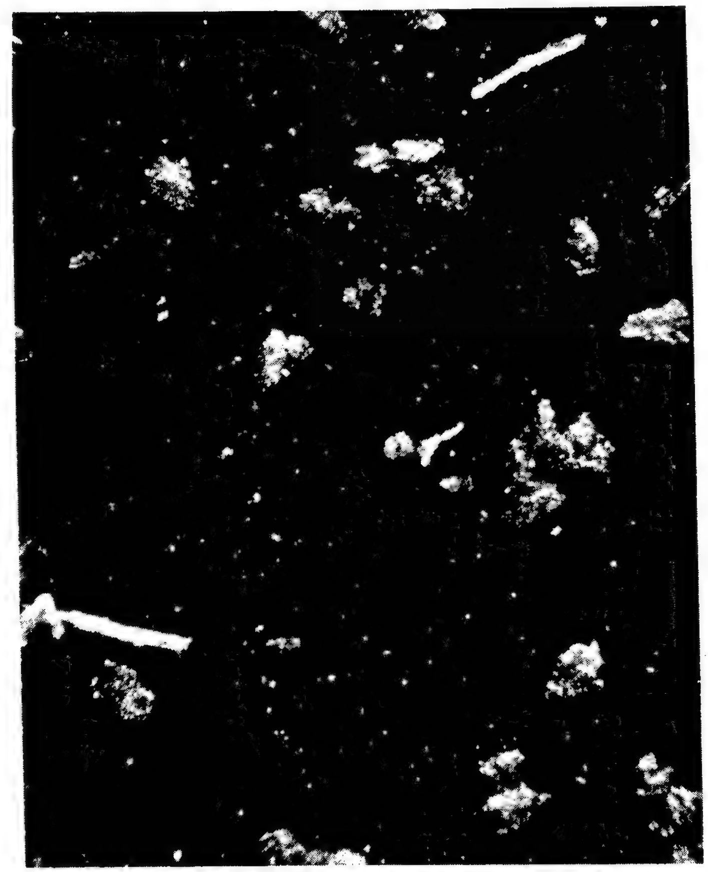
Particle Size: 0.354 mm
Magnification: 63X

Particle Size: 0.210 mm
Magnification: 63X

Particle Size: 0.149 mm
Magnification: 63X

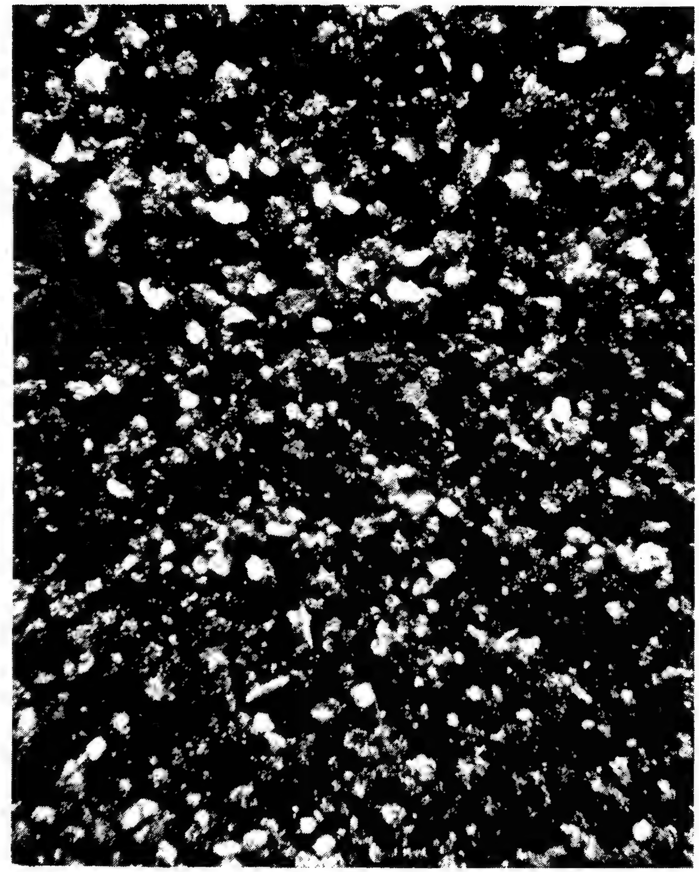


Particle Size: 0.105 mm
Magnification: 63X



Particle Size: 0.074 mm
Magnification: 63X

Particle Size: 0.053 mm
Magnification: 63X



Particle Size: 0.037 mm
Magnification: 63X

APPENDIX D

RELATED INFORMATION AND PROCEDURES

1. Memo, to Commanding General, AOD&P from Steeger, D. E., Picatinny, subject: "Projectiles for NERVA Test," dated July 8, 1965.

2. Rad Safe Procedures for NERVA Shot (APG #3), Aberdeen Proving Ground.

3. Standing Operating Procedure for Static Detonation of High Explosives for Test Purposes, U. S. Army D&PS, AMR 097.100, Aberdeen Proving Ground, Maryland, September 10, 1959.

4. Standing Operating Procedure--Static Deontation of High Explosives for Test Purposes, U. S. Army D&PS, AMR 097.100, Supplement No. 4, Aberdeen Proving Ground, Maryland, dated October 25, 1962.

5. Standing Operating Procedure--Evaluation of Fragments Obtained from the Experimental Destruction of a Simulated Atomic Reactor, U. S. Army D&PS, Procedure No. 097.265, Aberdeen Proving Ground, May 5, 1965.

6. D38: Its Properties and Its Controls, U. S. Army D&PS, Aberdeen Proving Ground, Maryland.

7. Standing Operation Procedure--Firing of Weapons Within D&PS (Ground to Ground and Ground to Air), U. S. Army D&PS, AMR 097.67, Aberdeen Proving Ground, Maryland, dated January 9, 1963.

COPY

UNITED STATES ARMY
PICATINNY ARSENAL Mr. Adelman/hek/4953
DOVER, NEW JERSEY, 07801

JUL 8 '65 11 22 AM

-DR4

SUBJECT: Projectiles for NERVA Test

TO: Commanding General
U. S. Army Ordnance Development & Proof Services
ATTN: STEAP-DS-TA (Mr. Howager)
Aberdeen Proving Ground, Maryland 21005

The subject projectiles were loaded with 94/6 DATB/polystyrene and PB-RDX boosters. Weights were as follows:

Projectile No.	Empty Weight (lb)	Loaded Weight (lb)	Total Weight of HE* (lb)
1	55.76	83.57	27.81
2	55.91	83.84	27.93
3	55.90	83.68	27.78
4	55.61	83.26	27.65

*Includes 1.21 lb PB-RDX booster

FOR THE COMMANDER:

D. E. SEEGER
Chief, Explosives Application Section

Copy furnished:
✓Mr. R. E. Berry, Dept 9312
P.O.Box 5800, Sandia Base
Albuquerque, N.M. 87115

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ABERDEEN PROVING GROUNDS

Rad Safe Procedures for NERVA Shot (APG #3)*

1. SOP's

AMR 097.100, Suppl. No. 4 will be used in the field.
DP 097.265 will be used in the lab.

2. Radiation Protection Officers

John Feroli in the field.
Robert Huddleston in the lab.

3. Order of Reentry

Will be controlled by test director. In general it will be as shown below. Some personnel will serve in more than one group.

First Group

At T + 15 min. entry will be made by personnel to cover battery jars; and by cameramen to remove film. This group will be kept to a minimum.

Second Group

Documentary photographers will take pictures in areas where battery jars have been covered.

Third Group

Following the covering of battery jars and removal of film, fragment recovery personnel will commence operations. Battery jars and cameras will be removed as appropriate.

4. Protective Clothing

First and Second Groups

Respirators, foot coverings, gloves (cotton OK), surgical caps, and coveralls over own clothing as desired. Openings of foot coverings and coveralls sealed with tape.

Third Group and Clean-up Personnel

Same as above except all personal clothing (except shoes and socks) will be removed, and personnel will be given a choice of one or two sets of coveralls, the choice being governed by desire for personal warmth. Provisions will be made for showers, at a location near test site, before going home. Also washing facilities will be available.

*From meeting of Messrs Feroli, Huddleston, Thune, Swindell, Holwager, Dutschke, Webster, T. Lyon and Lt. McNaughton, 8 June 1965.

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5. Dosimetry and Monitoring Equipment at Test Site

Film badges (covered with Saran wrap) - all personnel engaged in reentry.

Hand-carried air monitor to be used by one man who will monitor air in vicinity of personnel cleaning hard-topped area.

One continuous-reading air monitor placed at the nearest location that unprotected personnel will be permitted after the shot (about 600 ft away).

No protective equipment, film badges, etc. for observers.

6. Cameras

Each camera will be covered with plastic except for opening for lenses and cord. Upon removal of film, plastic will be replaced. Later, cameras will be removed and exposed camera sections will be cleaned with dry paint brush and wipe tests performed on representative cameras. Cameras will be held at suitable location until cleared by results of wipe tests.

7. Observers

Observers will be located at C-Tower area. A wind direction indicator will be located at C-Tower. Following shot, in the event that wind shifts in a way to carry cloud to observers, observers will enter buildings and remain within building for a suitable period of time. Observers are not expected to return to test site. Personnel monitoring (GM meter) will be available.

8. Downrange Areas

Poverty Island. Personnel at Poverty Island will be alerted to the fact that they must take cover for $1\frac{1}{2}$ hours on day of shot. As soon as information is known on shot time they will take cover from T-15 min to T + 75 min. A choice will be given them to stay indoors and close windows, or evacuate area.

Romney Creek. No problem - no test activities scheduled.

Game Warden's House. No concern - at a considerable distance from shot and occupants are employed elsewhere during day.

Ammunition Magazines. No concern - far from shot and not in direct downwind direction.

Old Baltimore Road. No concern because of the combination of distance and direction from shot.

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9. Downrange Monitoring

Three air monitoring stations will be set up in a line perpendicular to the expected direction of dust cloud and as far apart as possible, two at Poverty Island and one in Romney Creek area.

10. Clean Up

Once all fragments have been recovered for purposes of data analysis, all obvious shot residue will be cleaned up. This is not expected to start until some day following the shot. Residue mixed with dirt from the ground will be shovelled into barrels, whose covers will be taped, and sent to Edgewood Arsenal. The exact method of collecting residue will be decided after the shot. It is expected, however, to consist of scraping a thin layer from the ground, perhaps with shovels. It is not expected that this scraping will go beyond the area of 100'-radius which has been covered with oil or calcium chloride.

11. Rad Safe Orientations

A short orientation will be given by J. Feroli to representative personnel at Poverty Island and to test personnel, as well as to anyone else as appropriate.

12. Personnel Monitoring

A GM meter will be used to monitor personnel before removal of protective clothing, and afterwards.

13. Vehicles

Vehicles with possible contamination will be monitored. If required, decontamination will be initiated in the form of washdown with hose (any location OK) or brushing.

14. Instrumentation and Equipment that May be Contaminated

Instrumentation and equipment that has a possibility of being contaminated should be covered with plastic before ~~during~~ shot if feasible. Following shot items will not be removed from Bombing Field area until either (a) items are brushed and checked out with wipe tests or (b) items are completely covered for shipping elsewhere.

JOHN A. FEROLI
Radiation Protection Officer

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ABERDEEN PROVING GROUND

DEVELOPMENT AND PROOF SERVICES

ADMINISTRATIVE MANUAL

AMR 097.100
Vol 5, Book 320

10 September 1959

SUBJECT: Standing Operating Procedure for Static Detonation of High Explosives for Test Purposes

---

RESCISSION: AMR 097.100 dated 6 February 1956 and all supplements and addenda thereto. For underwater detonation see Supplement No. 1 to this SOP.

1. PURPOSE: To establish safe operating procedures and assign responsibility for operations pertaining to static detonation of high explosive items employing electric initiation. Operations not adequately covered by this procedure must be included in an approved supplement to this SOP.

2. APPLICABILITY: This procedure applies to tests which require static detonation of high explosives such as bare charges, fillers in projectiles, and similar items where the initiating device is installed at the test site immediately prior to detonation. Assembly, disassembly and machining operations necessary to prepare an item for static detonation will be accomplished at Building M700A in accordance with applicable operating procedures. The only operation permitted at the test site is installation of the initiating device.

3. RESPONSIBILITY:

a. Each individual assigned to the operation is individually responsible for personal compliance with applicable provisions of this procedure.

b. The unit or section chief of each supporting organization is responsible that each employee furnished the Project Engineer has been adequately trained in his duties and that prior to the test has been thoroughly briefed as to his duties and responsibilities and the hazards involved.

c. The Project Engineer is responsible for overall supervision of the test and for application and enforcement of the SOP.

4. LIMITS:

a. Personnel: Operating personnel are restricted to the number required to conduct the test in a safe and efficient manner. Transient personnel are restricted to those having an official interest in the test. At no time will the total number of personnel present exceed the capacity of the bombproof or shelter.

b. Explosives: The amount of explosives permitted at the test site is restricted to the amount required to conduct the test safely and efficiently. Explosives quantities at the detonation site will not exceed the number of components required to make up one static charge.

AMR 097.100

10 September 1959

5. RESTRICTIONS AND PRECAUTIONS:

a. Smoking or the use of flame and spark producing devices is restricted to properly posted buildings or areas approved in writing by Director, Development and Proof Services.

b. Initiating devices will be stored apart from all other explosives unless they are integral parts of the items involved. As separate items they will be retained in metal or metal lined containers until just prior to assembly to the test items.

c. Handling and emplacement of explosive test items, including their priming and detonation, will be accomplished only by Explosives Operators or individuals who have successfully completed an accepted course of instruction in this type operation, and whose names are included on a list of authorized personnel, submitted and approved by the operating agency and retained on file in Range Control Section, Range Service Branch. (Where hereafter used, the term 'Explosives Operator' is intended to include not only those bearing this title, but also those individuals who have successfully completed the required course and are authorized to perform in this capacity).

d. No electrical firing circuit will be established within one quarter (1/4) mile of a radio transmitter or within one (1) mile of a radar unit unless operation of the latter units has definitely been suspended for duration of the static test.

e. The handle of the blasting machine, or the one key thereto, will be retained in the personal possession of the individual assigned to accomplish the explosive portion of the mission.

6. PROTECTIVE EQUIPMENT:

a. All operating personnel will wear safety toe shoes while performing their duties (non-conductive soles in the field, conductive sole when on conductive floors, mats and runners).

b. The Explosives Operator, in addition to the shoes, will wear safety glasses or an approved type face shield during the priming operation.

7. STRATOSPHERE CHAMBER: This procedure applies to static tests of bare charges within the Stratosphere Chamber, with the following limits established for the weight of any explosives to be detonated at any one time. Weights in excess of those listed must have prior approval of Range Service Branch -

Sea Level - 30,000' - $1\frac{1}{2}$ lbs.
30,000 to 60,000' altitude - $2\frac{1}{2}$ lbs.
60,000 ft. altitude and above - 3 lbs.

The above values apply only when the charge is centrally located within the chamber. Any change to this condition must be covered by an approved supplement to this SOP.

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AMR 097.100

10 September 1959

8. OPERATIONAL EQUIPMENT AND MATERIALS: The following equipment and materials are deemed necessary for safe and efficient operation and will be employed during the subject operation:

a. DuPont Voltohmeter: To be used in testing firing wires for determination of continuity, resistance, and the presence of extraneous currents.

b. Firing wire, twisted pairs, no smaller than 20 gauge, will be employed to establish the firing circuit. In exceptional cases, when twisted pairs are not adaptable to the particular test involved or are not available for use within a reasonable period of time, single strand wire in pairs may be employed providing prior approval is obtained thru the Safety Office, D&PS from Director of Safety.

c. Grounding Rod: A copper grounding rod, 5/8" in diameter, will be driven adjacent to the firing point as means of grounding the firing wires as required at various steps in the operation. The rod will be driven to such a depth as to offer a resistance no greater than 25 ohms.

d. Blasting Machine: A blasting machine of adequate type and voltage to initiate the detonation.

e. Initiating Devices: Only the following initiators are acceptable under the provisions of this SOP:

(1) #6 Blasting Cap

(2) #8 Blasting Cap

(3) Special Army Electric Blasting Cap, Type II, PETN (Engineers Special).

(4) M36 and M36A1 Detonators.

f. Two fire extinguishers, water type, will be available for combating incipient fires which may occur as a result of the test. In established static detonation areas, selected and approved by Range Control Section, Range Service Branch, the fire extinguishers will be placed, housed, and maintained by the APG Fire Department. In other areas, as for particular tests or to meet special requirements, fire extinguishers will be furnished for each mission by the units authorized to accomplish the mission. The foreman or worker in charge of such operation is responsible for reporting to Chief, Fire Department, at conclusion of each day's mission, the need for replenishment or replacement of any extinguisher which may have been depleted or made inoperative during the day's operation.

g. A special carrying box, metal or metal lined, will be used for transportation and temporary storage of initiators at the test site.

AMR 097.100

10 September 1959

9. PROCEDURE:

a. Drive the grounding rod immediately adjacent to the firing shelter and check for resistance.

b. Twist the power ends of the firing wires together and attach to the grounding rod so as to make a clean and secure contact. Extend the wires to the point of detonation, attach to the DuPont-Voltohmeter and check for the presence of extraneous currents. If extraneous currents are encountered, no further steps will be taken until their source has been corrected or eliminated.

c. Obtain one test item from the storage site or carrier and emplace in position.

d. All personnel except the Explosives Operator will retire to cover in the bombproof or firing shelter.

e. The Explosives Operator will obtain an initiating device (blasting cap or detonator), attach it to the firing wires and then insert the device into the test item. The device will be kept shorted until the moment of connecting it to the firing wires.

f. The Explosives Operator will then retire to cover, disconnect the firing wires from the grounding rod and attach them to the DuPont Voltohmeter to determine continuity of the circuit.

g. If continuity is not determined, the Explosives Operator will disconnect the voltohmeter, again short and ground the firing circuit to the grounding rod, and check the wires and connections to determine and correct the cause of failure.

h. When continuity has been established, the Project Engineer will obtain clearance from the appropriate Control Tower to conduct the test.

i. The Explosives Operator will then attach the firing wires to the blasting machine and, upon signal from the Project Engineer, detonate the charge.

j. All personnel will remain under cover until danger from fragments is over.

10. MISFIRES: In event of a misfire, the Explosives Operator will make several attempts to fire the charge. If the charge still fails to detonate, the firing wires will be disconnected from the blasting machine, shorted and grounded, and a waiting period of thirty minutes under cover observed by all personnel. At conclusion of the waiting period, the Explosives Operator, alone, will leave shelter to determine and correct the cause of failure. All other personnel will remain under cover until the cause of failure has been corrected and the charge detonated.

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11. ELECTRICAL STORMS: Preparation for static detonation involving electrical firing circuits will not be made during the presence or approach of an electrical storm. Upon approach of a storm, the handling of munitions or explosives and the placement or check of firing circuits will be discontinued and personnel will remain under cover. However, in such cases where preparations have been completed prior to an electrical storm approaching the area, the detonation may be accomplished providing there is no misfire.

12. A copy of this SOP and applicable changes or supplements thereto will be posted at the firing point throughout the operation.

RECOMMENDING APPROVAL:

E. L. Budnick

E. L. BUDNICK
Chief, Range Service Branch

J. A. Tolen

J. A. TOLEN
Acting Deputy Director for Supporting Services

H. A. Noble

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WILLIAM C. KLEIN, JR
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for PAUL V. KING
Director of Safety

APPROVED:

Robert U. Walnes

ROBERT U. WALNES
Major, Ord Corps
Executive Officer

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ABERDEEN PROVING GROUND

Development and Proof Services

ADMINISTRATIVE MANUAL

Supplement No. 4
AMR 097.100
Vol 5, Book 320
25 October 1962

STANDING OPERATING PROCEDURE
STATIC DETONATION OF HIGH EXPLOSIVES FOR TEST PURPOSES

RESCISSION: AMR 097.100, (Supplement No. 4, dated 31 July 1961)

REFERENCES: Not Applicable

1. PURPOSE: To extend coverage of the basic SOP to include static detonation of ammunition containing D-38 (including depleted uranium, tuballoy or U238) and to further accommodate the static detonation of shaped charges against tuballoy plate. All provisions of the basic SOP apply except where specifically exempted or modified by this supplement.

2. APPLICABILITY: This supplement covers all calibers of ammunition and all standard shaped charges when employed against tuballoy plate.

3. RESPONSIBILITY: In addition to those responsibilities cited in the basic procedure, the following will also apply. The D&PS Radiological Safety Officer, or his designated representative, will:

a. Instruct all personnel connected with the test of the radiation hazards involved and precautions to be observed.

b. Issue and collect all film badges and dosimeters daily, maintaining a current log of all personnel exposures.

c. Ensure that ultra-filter respirators are available to personnel actively working within the area and are worn by them when required by conditions existing at the time of their engagement in the operation.

d. Ensure that all personnel entering the impact area wear protective coveralls, gloves, and boots, and that these garments are not removed from the area except when:

(1) Monitoring has definitely revealed that they are free of contamination or

(2) They are being transported in suitable closed containers to Edgewood Arsenal for decontamination or disposal.

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e. Be responsible for maintaining an up-to-date log of the location and quantity of D-38 within the test area for purposes of later removal or destruction.

f. Monitor all personnel and equipment prior to their vacating the test area, or any other area where there is reason to believe D-38 has been deposited, except when the Radiological Safety Committee, after review of the log, has determined that the contamination is negligible. Monitoring may be discontinued when records indicate that such a condition exists.

g. Institute decontamination procedures and supervise collection of all surface radioactive material for delivery to Edgewood Arsenal for disposal. Also to supervise scraping of any surface area containing uncollectable radioactive material and to arrange for the covering of this material with earth, posting the area and logging its location. This work must be accomplished and approval of the Radiological Safety Committee obtained prior to opening the area to general access, to ensure that no contamination may be carried or spread from the area.

4. LOCATION OF OPERATIONS: All D&PS test areas may be considered as suitable for the test of D-38 ammunition providing all provisions of this procedure are observed. However, selection of test areas should be restricted as far as possible and limited to those receptive to monitoring and bulldozing should such requirements arise. Normally tests will be conducted on the contaminated area of the New Bombing Field except where test requirements make it impractical or uneconomical to do so, and after command approval has been obtained. The new Bombing Field, until otherwise indicated by the Radiological Safety Committee, will be considered mildly contaminated but presenting no health hazard. The area will be kept posted and identified as containing depleted uranium and personnel entering the area will wear approved foot coverings.

5. PERSONNEL LIMITS: Same as in basic SOP.

6. MATERIAL LIMITS: Same as in basic SOP.

7. SAFETY REQUIREMENTS:

a. Physical examinations will be given as prescribed by APG AMR 3-385-8, to personnel expected to be assigned to regular duty in radiation exposure areas. The decision as to whether or not a physical examination is required will be made by the D&PS Radiological Safety Officer after consultation with the chairman of the Radiological Safety Committee and Post Surgeon.

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b. Eating,drinking and smoking are prohibited within the test areas. Furthermore, neither food nor tobacco will be carried into these areas.

c. Storage areas containing 5 millicuries or more of D-38 will be conspicuously posted with applicable radiation symbols.

d. Personnel shelters should be located upwind from the detonation site.

e. At discretion of the Radiological Officer the detonation site and immediate area will be watered down prior to the detonation so as to reduce dust clouds as much as possible.

f. Following a detonation, personnel will not enter the area until after a waiting period of at least fifteen (15) minutes or until the dust has settled, whichever period is greater. Monitoring of the air will be accomplished before entry to ensure that such entry is safe.

g. Upon completion of a program, the D&PS Radiological Safety Officer, based on accrued data, will request a judgement from the Radiological Safety Committee as to the subsequent control required in the test area and the decontamination procedures to be employed prior to returning the area to normal usage.

h. Personnel will not physically handle any D-38 projectiles or fragments of tuballoy for more than six (6) hours in any seven-day period without prior approval of the D&PS Radiological Safety Officer.

i. Washing facilities will be provided and, prior to eating, drinking or smoking, personnel will remove protective clothing and thoroughly wash face and hands.

8. PERSONNEL PROTECTIVE CLOTHING:

a. Foot coverings, of rubber or plastic, will be worn by all personnel entering an area where D-38 ammunition has been detonated, except when the Radiological Safety Committee has previously determined that the amount of contamination is so negligible that their use is not necessary.

b. Gloves, rubber or leather, will be worn by all personnel handling known or suspected sources of radiation (projectiles, fragments, or recovery media).

c. Respirators with ultra-type filters will be kept available and donned immediately by personnel whenever a dust cloud resulting from a detonation may be blown in their direction. Respirators will be removed at the discretion of the Radiological Safety Officer.

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9. TOOLS: Not applicable.

10. PROTECTIVE EQUIPMENT: All personnel expected to handle or to come into contact with any projectiles or plate targets, as outlined in Paragraph 1 above, or fragments thereof, will wear film badges. Pocket dosimeters will also be carried at discretion of the D&PS Radiological Safety Officer.

11. OPERATING EQUIPMENT: Same as in basic SOP.

12. PROCEDURE: Same as in basic SOP.

13. MISFIRES: Same as in basic SOP.

14. ELECTRICAL STORMS: Same as in basic SOP.

15. A copy of this supplement and one of the basic procedure must be posted at each test site during actual operations.

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RECOMMENDING APPROVAL:

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Executive Officer

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U. S. ARMY
DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND
MARYLAND

D&PS PROCEDURE
NO. 097.265

5 May 1965

STANDING OPERATING PROCEDURE
EVALUATION OF FRAGMENTS OBTAINED FROM THE
EXPERIMENTAL DESTRUCTION OF A SIMULATED ATOMIC REACTOR

RESCISSION: None

REFERENCES: APGR 385-8

1. PURPOSE: To establish safe procedures to be followed when handling depleted or natural uranium fragments obtained as a result of the experimental destruction of a simulated atomic reactor.

2. APPLICABILITY: The provisions of this procedure pertain to all personnel handling radioactive material obtained as a result of the experimental destruction of a simulated atomic reactor.

3. RESPONSIBILITY:

a. All operating personnel will be responsible for conforming to the provisions of this SOP and the regulations established by the AEC and local authorities for the safe use of ionizing radiation.

b. The appropriate Area Radiation Protection Officer is responsible for the safety of operating personnel and instructing them as to the hazards involved. He or his designated representative will be present during all operations in a Radiation Area.

4. LOCATION OF OPERATIONS: All laboratory operations involving radioactive materials will be carried out in Building 362 or at another site having the prior approval of the Radiation Protection Officer.

5. PERSONNEL LIMITS: The number of personnel in the operations area will not exceed that necessary to accomplish the mission safely and efficiently.

6. MATERIAL LIMITS: 100 Kg depleted or natural uranium fuel rods or the equivalent quantity of fuel rod fragments.

7. SAFETY REQUIREMENTS:

a. Radiation Signs

(1) The perimeter of any area in which a person could receive a radiation dose in excess of 2 mrem in one hour or 60 mrem in five consecutive days will be posted with a "Radiation Area" sign.

(2) Any area in which the concentration of uranium in the air may exceed $1x10^{-11}$ microcuries per milliliter will be posted with a standard "Airborne Radioactivity Area" sign.

(3) The entrances to all areas containing an amount of uranium greater than 500 microcuries shall be posted with standard "Radioactive Material" signs.

b. Dosimetry

Film badges and direct reading pocket dosimeters will be worn by all personnel in a Radiation Area. A daily record of all pocket dosimeter readings will be kept.

c. Physical examinations as prescribed by APGR 385-8 will be given to all personnel expected to be assigned to regular duty in a Radiation Area.

d. Surveys

(1) Sufficient radiological surveys will be made of the operations area to insure that all Radiation Areas are properly marked.

(2) Periodic smear surveys of the operations area will be made to detect any radiological contamination as required by the RPO.

(3) Periodic air samples will be taken in the operations area to determine the concentration of airborne radioactive materials, as required by the RPO.

e. No individual will be allowed to receive a radiation dose greater than 100 mrem/wk with no daily dose being in excess of 50 mrem.

f. No smoking or partaking of liquids or food will be permitted in the operations area or in any area suspected of contamination.

g. Washing facilities will be provided for personnel. Prior to eating, drinking, or smoking, each person will remove his protective clothing and thoroughly wash his face and hands.

h. Protective coverings will be used on laboratory work surfaces whenever possible.

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5 May 1965

DP 097.265

8. PERSONNEL PROTECTIVE CLOTHING:

a. Disposable gloves will be worn by all personnel when handling known or suspected sources of radiation.

b. Coveralls or laboratory coats will be worn by all personnel in the operations area.

c. Foot or shoe coverings of rubber or plastic will be worn by all personnel in the operations area unless it has been previously determined that the amount of contamination is so negligible that their use is not necessary.

d. Respirators with ultra-type filters will be worn by all personnel in the operations area whenever there is the possibility of airborne contamination.

9. TOOLS: N/A

10. PROTECTIVE EQUIPMENT: N/A

11. OPERATING EQUIPMENT:

a. Film badges

b. Direct reading dosimeters

c. High and low intensity survey meters

d. Polyethylene film and bags

12. PROCEDURE: N/A

13. ELECTRICAL STORMS: Operations will be halted during electrical storms if the operations site is in the field.

14. DISPOSAL OF CONTAMINATED WASTES:

a. Solid contaminated wastes will be stored in suitably marked sealed waste containers and disposed of in accordance with the provisions of APGR 385-8.

b. All liquids suspected of contamination will be stored in a suitably marked sealed container. Prior to its disposition, any liquid so obtained will be analyzed to determine its uranium content. If the concentration of uranium is less than 2×10^{-5} microcuries/ml, the liquid will be disposed of as if it were not contaminated. If the concentration is greater than 2×10^{-5} microcuries/ml it will be disposed of in accordance with the provisions of APGR 385-8.

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DP 097.265 5 May 1965

15. A copy of this SOP will be posted at the site of operations.

SUBMITTED BY:

R. L. HUDDLESTON
Chief, Materials Evaluation Sect.

RECOMMENDING APPROVAL:

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WILLIAM V. WARREN
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Safety Committee

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Director of Safety

COPY

DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND, MARYLAND

D-38: ITS PROPERTIES AND ITS CONTROLS

Terminology - D-38, as the Army chooses to call it, is a uranium by-product of the atomic energy industry. It is more commonly referred to in the technical literature as depleted uranium, but it is sometimes called by its old code name of tuballoy or depleted tuballoy. It is often simply designated U-238 since it consists of over 99.7% of the U-238 isotope.

Uses - The greatest usage of D-38 is in connection with applications that require an extremely high-density material. Thus D-38 may be used in projectiles to influence ballistic characteristics. D-38 has a density of 18.7 grams/cm^3 as compared to 11.3 grams/cm^3 for lead. For most applications, tungsten - 19.3 grams/cm^3 - would serve just as well but the price of tungsten is prohibitive. D-38 may also be used to simulate enriched uranium (over 0.7% U-235) or plutonium.

Processing Methods - Refined natural uranium consists of three isotopes in the following proportions: 99.3% U-238, 0.7% U-235 and a trace of U-234. The refined natural uranium undergoes a series of processes wherein most of the U-235, which is the valuable isotope that can sustain a chain reaction, is progressively separated from the U-238. The remaining by-product, depleted of most of its U-235, is D-38; it contains only 0.2 to 0.3% U-235 and for practical purposes may be considered all U-238. Often, in order to add strength and corrosion resistance, the D-38 is alloyed with molybdenum up to about 10%, as it is in the Davy Crockett 20-mm spotter.

Radioactivity - Both U-235 and U-238, and so therefore D-38, are radioactive; that is, they emit radiation spontaneously and continuously. However, uranium isotopes are only mildly radioactive being some of the least radioactive of all radioactive isotopes on the basis of weight. D-38 emits alpha, beta and gamma radiations. Painting the D-38 is sufficient to suppress all of the alpha radiation; a metal jacket, e.g., copper, over the D-38 is enough to suppress both beta and alpha. Though certain restrictions are imposed because of the radioactivity, and cartons containing D-38 must be marked with radiation symbols, the radiation hazard from D-38 is considered minimal. Greater details on the radioactivity of D-38 are contained in Appendix A.

Contamination Potential - Contamination as used in the radiological sense has a somewhat different meaning than it does in the ordinary sense. It means any detectable amount of radioactivity above that of the background (cosmic rays, radioactive minerals, etc.). Though a laboratory or an area may be considered radioactively contaminated, it may not present any health hazard whatsoever. For example, any detectable amount of D-38 that is deposited on a D&PS range may result in the range being considered contaminated but

not a health hazard. This type of contamination is of concern only in that it should not be tracked around the Proving Ground into areas where it might ultimately find its way into laboratories where very low level radiation measurements may be undertaken. So far, no tracking of uranium out of a range has been detected.

Toxicity - D-38 is chemically toxic to the human body if taken internally in sufficient quantity. It will act much like lead which is capable of causing lead poisoning. Precautions to avoid inhaling or ingesting dust from D-38 are primarily aimed at protecting against the toxicity of uranium rather than its radioactivity.

Pyrophoric Properties - Slivers, dust or chips of D-38 can readily be ignited. Thus, precautions against uranium's pyrophoric properties must be taken during any machining operations. Some installations actually burn machine chips under controlled conditions to forestall any possibility of their igniting under unfavorable conditions. Alloying the D-38 with molybdenum will not permit a reduction in the precautions necessary to guard against the pyrophoric tendencies of fine particles. Slugs of D-38, however, are not considered a pyrophoric problem in that D-38 is very difficult to ignite in this form.

Regulations - Because D-38 is radioactive its handling automatically falls under the jurisdiction of the APG Radiological Safety Committee (on which D&PS has two members), the Army Surgeon General and the Atomic Energy Commission. With all of these regulatory agencies there are bound to be regulations. The D&PS Radiological Safety Officer is responsible for knowing these regulations and must be contacted whenever a program is going to involve D-38. He is permitted a certain amount of flexibility in rendering judgments in radiological matters. There is also a requirement that no operation with D-38 will be undertaken without an SOP. The three SOP's on D-38 that D&PS has in effect should cover most operations; these are: AMR 097.67, Suppl. No. 3 "SOP - Firing of Weapons Within D&PS (Ground to Ground and Ground to Air"), AMR 097.23, Suppl. No. 4, "SOP For Field Recovery of Test Ammunition", and AMR 097.100, Suppl. No. 4, "SOP - Static Detonation of High Explosives for Test Purposes". The project engineer should follow the applicable SOP.

The regulations and AMR's reflect an extremely cautious attitude. They try, in essence, to accomplish the following:

a. Minimize Inhalation of D-38 Dust - This is principally for toxic reasons. Thus, respirators must be available and a 15-minute waiting period is currently required before entry into a test area is permitted following a detonation. Regulations concede that a small amount of inhaled dust is permissible (reference Appendix A).

b. Minimize Ingestion of D-38 Dust - This, too, is principally for toxic reasons. Thus, smoking and eating are prohibited and gloves are worn to keep any D-38 from rubbing off on hands that may later be used

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for eating. Government regulations permit the ingestion of probably more D-38 than anyone in D&PS could reasonably ever expect to ingest (reference Appendix A).

c. Prevent the Spread of Contamination - Monitoring of clothing, equipment and range areas is required to determine if any D-38 is being inadvertently carried out, or has the possibility of being carried out, of the range area. Experience has shown that the potential for spreading D-38 contamination is not very great and that such monitoring will usually produce negative results, but it should be performed nevertheless. The D&PS Radiological Safety Officer is familiar with the means for handling and disposing of contaminated clothing and test materials, for example, celotex. In the event that contamination should someday become a problem, ranges for firing projectiles containing D-38 are limited to as few as is practical and economical, and an inventory is maintained of the amount of D-38 deposited in each range. Significant contamination of a range may require bulldozing or posting of signs, but usually leaching of the dense uranium into the soil will dissipate the contamination over a period of time. The SOP's make provision for returning ranges to normal usage, that is, no foot coverings, monitoring, film badges, etc., required.

d. Provide Assurance of Insignificant Radiation Exposure - Film badges, which provide an official record of radiation exposure (or lack of exposure) of individuals, are normally issued to personnel handling D-38. Because of the low level of radiation from D-38, it is extremely unlikely that the film badges will register any radiation exposure whatsoever. The radiation from the D-38 is also responsible for limiting the time personnel may hold D-38 in their hands to 6 hours per week. This is sufficient time to cause no operational inconveniences in D&PS. The 6-hour limitation is conservatively based upon permissible exposure to each bare hand per week from unalloyed natural uranium (reference Appendix A).

Monitoring Techniques - A Geiger-Mueller counter, sometimes called a GM meter or a Geiger counter, is usually used for monitoring D-38. It is a very sensitive instrument as can be ascertained by the considerable reading it will register when placed next to a slug of D-38 or a watch with luminous hands. When the metal shield of the probe of the GM meter is turned aside to expose the Geiger tube, the meter registers both gamma and beta. With the shield in place in front of the tube, only gamma is registered. Monitoring should be performed with the shield open and the probe held close to the object that is being monitored. A significant jump in intensity will indicate contamination. Contamination can then easily be pinpointed and the radioactive material collected for disposal in accordance with instructions from the Radiological Safety Officer.

Summary: D-38 is chemically toxic, as are most heavy metals, and mildly radioactive. Because of these two properties D&PS is obligated to abide by certain regulations. These regulations should, however, present no more than minor inconveniences to D&PS operations. Considering the form

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in which D-38 will be employed in D&PS there is no hazard to personnel except where there is the most flagrant and irresponsible disregard for reason.

John A Feroli

JOHN A. FEROLI
Special Assistant to Deputy
Director f/Engr Testing
5 February 1963

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APPENDIX A

Selected Data Pertaining to the

Radioactivity of D-38

The table below shows how extremely low are the radioactivity ratings of U-238 and U-235 on the basis of weight in comparison to other well-known radioisotopes:

Radioisotope	Specific Activity in Microcuries/Gram
U-238	0.34
U-235	2.1
Radium - 226	1.0×10^6
Cobalt - 60	1.1×10^9

Though very weak in the above comparison, D-38 (99.7 + % U-238) is definitely radioactive and, together with its daughter products, emits the following radiations:

Radiation from D-38	Range in Air	Can be Stopped by
Gamma rays	Hundreds of feet[a]	An inch or two of steel[a]
Beta particles	Up to 20 feet	Thin sheet of metal
Alpha particles	About 1 inch	Skin or sheet of paper

[a]The range and penetrating ability of gamma rays are dependent upon their energy levels. Since practically all of the gamma emissions from D-38 have low energies, the figures given here may, for all practical purposes, be considered adequate. However, there are in the atomic field other radioisotopes which emit high-energy gamma rays. In such cases the proper notations would be "several miles" and "many inches of steel."

The radiations from a slug of D-38 are so complex as to almost defy analysis. Part of this complexity is due to such things as bremsstrahlung, photoelectric effect, and self absorption; and part is due to the formation of radioactive decay products - daughters - each of which (by the time the D-38 becomes part of a finished product and equilibrium has been reached) decays atom for atom with the parent isotope. Though theoretically the refining and separation processes separate the U-238 from all its daughters, radioactive decay starts the daughters forming again immediately. This situation is depicted below:

Progeny	Radioisotope	Type Emissions	Half Life
Parent	U-238 ↓	Alpha, Gamma[b]	4.5×10^9 years
Daughter	Thorium - 234 ↓	Beta, Gamma	24 days
Daughter	Protactinium - 234 ↓	Beta, Gamma	1.2 minutes
Daughter	Uranium - 234	(see below)	2.5×10^5 years

[b]This gamma is of very low energy and occurs only one-fifth as often as the alpha.

Because of the long half life of U-234 and the small amount of this isotope that will be built up, the process may be considered ended here. (This is not the case with uranium mining operations, however, because the uranium in the earth has been decaying since the beginning of the universe, and a string of twelve daughter products has had time to develop, the most hazardous being radium with its high-energy gamma emissions and radon which is a radioactive gas.)

Maximum permissible concentration (MPC's) of U-238 for continuous occupational exposure have been established by the National Committee on Radiation Protection. The limiting amounts for 168 hours per week of exposure are:

In drinking water - 4×10^{-4} microcuries/cc[c]

In air - 3×10^{-11} microcuries/cc[c]

[c]These figures are actually based upon chemical toxicity, which is the limiting criterion for U-238, rather than radioactivity.

In terms of the maximum weight of U-238 that an employee is permitted to take internally each week, this amounts to:

Permissible ingestion of U-238 - 323 grains (21 grams) per week

Permissible inhalation of U-238 - 0.2 grains per week

Investigators have determined that a slug of unalloyed natural uranium emits 239 millireps/hour of beta radiation at its surface. In this case a rep may be considered about the same as a rem; therefore, natural uranium will produce a dose of slightly over 250 millirems/hour when the beta is combined with the gamma. Regulations permit exposure of 75,000 millirems per year to hands and feet. Based upon these values, it was determined that the permissible time that D-38 may be held in the hands is about 6 hours per week on the average.

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ABERDEEN PROVING GROUND

Development and Proof Services

ADMINISTRATIVE MANUAL

Supplement No. 3
AMR 097.67
Vol 5, Book 320
9 January 1963

STANDING OPERATING PROCEDURE
FIRING OF WEAPONS WITHIN D&PS (GROUND TO GROUND & GROUND TO AIR)

RECISSIONS: AMR 097.67 (Supplement No. 3, dated 12 June 1961 and all changes thereto.

REFERENCES: AMR 3-385-8

1. PURPOSE: To extend coverage of the basic SOP to include firing of projectiles containing D-38 (including depleted uranium, tuballoy, or U-238) and the firing of high explosives against depleted uranium targets.

2. APPLICABILITY: This supplement covers all calibers of ammunition and includes both inert and live-loaded projectiles. All provisions of the basic procedure apply except where specifically exempted or modified by this supplement.

3. RESPONSIBILITY: In addition to those responsibilities cited in the basic procedure, the following will also apply. The D&PS Radiological Safety Officer, or his designated representative, will:

a. Instruct all personnel connected with the test of the radiation hazards involved and the precautions to be observed.

b. Issue and collect all film badges and dosimeters daily, maintaining a current log of all personnel exposures.

c. Ensure that ultra-filter respirators are available to personnel actively working within the area and are worn by them when required by conditions existing at the time of their engagement in the operation.

d. Ensure that all personnel entering the impact area wear protective coveralls, gloves and boots, and that these garments are not removed from the area except when:

(1) Monitoring has definitely revealed that they are free of contamination or

(2) They are being transported in suitable closed containers to Edgewood Arsenal for decontamination or disposal (AMR 3-385-8).

e. Be responsible for the area location of all impacts and maintaining an up-to-date log of the location and quantity of D-38 within the impact area for purposes of later removal or destruction.

f. Monitor all personnel and equipment prior to their vacating the impact area, or any other area where there is reason to believe D-38 has been

deposited, except when the Radiological Safety Committee, after review of the log, has determined that the contamination is negligible. Monitoring may be discontinued when records indicate that such a condition exists.

g. Institute decontamination procedures and supervise collection of all surface radioactive material for delivery to Edgewood Arsenal for disposal in accordance with AMR 3-385-8. Also to supervise scraping of any surface area containing uncollectable radioactive material and to arrange for the covering of this material with earth, posting the area and logging its location. This work must be accomplished and approval of the Radiological Safety Committee obtained prior to opening the area to general access, to ensure that no contamination may be carried or spread from the area.

4. LOCATION OF OPERATIONS: All D&PS impact areas may be considered as suitable for the impacting of D-38 projectiles providing all provisions of this procedure are observed. However, selection of impact area should be restricted as far as possible and limited to those receptive to monitoring and bulldozing should such requirements arise. Normally, the firings will be conducted so as to impact the projectiles on the contaminated area of the New Bombing Field except where test requirements make it impractical or uneconomical to do so, and after command approval has been obtained. A portion of the New Bombing Field has been recorded as containing buried D-38 deposited during test operations. If the D-38 were exposed, the area would be considered mildly contaminated but presenting no health hazard. Whenever recovery operations or shell detonations have the potential of causing a substantial disturbance of the soil sufficient to penetrate the overburden, monitoring will be conducted as deemed appropriate by the Radiological Safety Officer.

5. PERSONNEL LIMITS: Same as in basic procedure.

6. MATERIAL LIMITS: Same as in basic procedure.

7. SAFETY REQUIREMENTS:

a. Physical examinations will be given, as prescribed by APG AMR 3-385-8, to personnel expected to be assigned to regular duty in radiation exposure areas. The decision as to whether or not a physical examination is required will be made by the D&PS Radiological Safety Officer after consultation with the chairman of the Radiological Safety Committee and Post Surgeon.

b. Eating, drinking and smoking are prohibited at the firing site and within the impact areas. Furthermore, neither food nor tobacco will be carried into these areas.

c. Storage areas containing 5 millicuries or more of D-38 will be conspicuously posted with applicable radiation symbols.

d. Firing will not be conducted when the wind direction is such that a dust cloud resulting from a detonation can be expected to be blown toward personnel.

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e. Following a detonation, either over or upon an impact area, personnel will not enter the area until after a waiting period of at least fifteen (15) minutes or until the dust has settled, whichever period is greater. Monitoring of the air will be accomplished before entry to ensure that such entry is safe.

f. Upon completion of a program, the D&PS Radiological Safety Officer, based on accrued data, will request a judgement from the Radiological Safety Committee as to the subsequent control required in the impact area and the decontamination procedures to be employed prior to returning the area to normal usage. Plate, plate butts and immediate surrounding area will be decontaminated at completion of each test and restored to service in their former condition.

g. Personnel will not physically handle any D-38 projectiles or fragments of tuballoy for more than six (6) hours in any seven-day period without prior approval of the D&PS Radiological Safety Officer.

h. All personnel at the firing site must be under adequate cover when a round is fired as prescribed in the basic SOP. Cover must also provide shelter from any radioactive contamination as may be received from airborne particles of D-38 resulting from malfunction of the weapon or ammunition at the time of firing.

i. The line of fire will be established so as to reduce as far as possible any danger of contamination of personnel or facilities from an airburst occurring at any point along the trajectory. No D-38 projectile will be fired on a line that might result in a water impact.

j. A layer of absorbent material will be spread at the base of the plate butt, at the discretion of the Radiological Safety Officer. Air samples will be taken during firing. Approval of the Radiological Safety Officer will be required before resuming normal test operations in the affected area.

k. Washing facilities will be provided for personnel and, prior to eating, drinking or smoking, each person will remove protective clothing and thoroughly wash his face and hands.

8. PERSONNEL PROTECTIVE CLOTHING:

All operational personnel required to work on or near the plate and butts during conduct of the test will wear respirators, coveralls and rubber boots. Personnel so protected may perform their assigned duties after each round fired upon obtaining routine clearance from Range Control Tower. The waiting period prescribed in paragraph 7 f above need not be observed in this operation when personnel are protected as prescribed.

b. Foot coverings, of rubber or plastic, will be worn by all personnel entering an area where D-38 projectiles have impacted, except when the Radiological Safety Committee has previously determined that the amount of contamination is so negligible that their use is not necessary.

c. Gloves, rubber or leather, will be worn by all personnel handling known or suspected sources of radiation (projectiles, fragments, or recovery media).

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d. Respirators with ultra-type filters will be kept available and donned immediately by personnel upon occurrence of a premature or whenever a dust cloud resulting from detonation of a projectile may be blown in their direction. Respirators will be removed at discretion of the Radiological Safety Officer.

9. TOOLS: Not Applicable.

10. PROTECTIVE EQUIPMENT: All personnel expected to handle or come into contact with any projectiles or plate targets as outlined in Paragraph No. 1 above, or fragments thereof, will wear film badges. Pocket dosimeters will also be carried at discretion of the D&PS Radiological Safety Officer.

11. OPERATING EQUIPMENT: Not Applicable.

12. PROCEDURE: Not Applicable.

13. ELECTRICAL STORMS: Not Applicable.

14. A copy of the basic SOP and one of this supplement must be posted at each test site during actual operations.

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SUBMITTED BY:

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Chief, Artillery Division

RECOMMENDING APPROVAL:

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APPENDIX E

Trajectory Tabulations

NOTES:

FR = Arbitrary sequence number

TIME = Elapsed time from zero time

X = X-component of position

Y = Y-component of position

ALT = Mean-sea-level altitude

VAX = X-component of velocity with respect to origin

VAY = Y-component of velocity with respect to origin

VZ = Z-component of velocity with respect to origin

VA = Total velocity with respect to origin

M = Mach number

Q = Dynamic pressure

T.A. = Angle between vertical velocity vector and total velocity vector VA

WX = X-component of wind velocity

WY = Y-component of wind velocity

S. S. = Speed of sound

RHO = Air density

PA = Ambient pressure

TABLE E-1

DATA SUMMARY TEST SKIN 1 OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.030	-6	11	2								0.0	0.0	1116.44	0.0765	29.92
40002	0.040	-7	14	3	-192	373	93	430	0.3851	219.89	12.437	0.0	0.0	1116.44	0.0765	29.92
40003	0.050	-9	18	4	-202	393	97	453	0.4056	243.96	12.396	0.0	0.0	1116.43	0.0765	29.92
40004	0.060	-11	22	5	-202	394	99	454	0.4065	245.07	12.603	0.0	0.0	1116.43	0.0765	29.92
40005	0.070	-14	26	6	-190	371	80	425	0.3804	214.53	10.926	0.0	0.0	1116.43	0.0765	29.91
40006	0.080	-15	30	7	-182	354	77	405	0.3627	195.09	10.889	0.0	0.0	1116.42	0.0765	29.91
40007	0.090	-17	33	7	-171	333	73	381	0.3412	172.56	11.019	0.0	0.1	1116.42	0.0765	29.91
40008	0.100	-19	37	8	-166	323	77	371	0.3324	163.86	12.051	0.0	0.1	1116.42	0.0765	29.91
40009	0.110	-20	40	9	-163	317	78	365	0.3270	158.53	12.386	0.0	0.1	1116.42	0.0765	29.91
40010	0.120	-22	43	10	-168	327	72	375	0.3357	167.06	11.134	0.0	0.1	1116.41	0.0765	29.91
40011	0.130	-24	46	10	-173	336	68	384	0.3443	175.74	10.245	0.0	0.1	1116.41	0.0765	29.91
40012	0.140	-26	50	11	-176	343	71	393	0.3516	183.31	10.473	0.0	0.1	1116.41	0.0764	29.91
40013	0.150	-27	53	12	-171	334	73	382	0.3424	173.80	10.950	0.0	0.1	1116.41	0.0764	29.91
40014	0.160	-29	56	13	-162	316	76	363	0.3256	157.12	11.992	0.0	0.1	1116.40	0.0764	29.91
40015	0.170	-30	59	13	-162	315	75	362	0.3246	156.19	11.908	0.0	0.1	1116.40	0.0764	29.91
40016	0.180	-32	62	14	-158	308	84	356	0.3190	150.84	13.646	0.0	0.1	1116.40	0.0764	29.91
40017	0.190	-34	66	15	-164	320	82	369	0.3307	162.06	12.825	0.0	0.1	1116.39	0.0764	29.91
40018	0.200	-35	69	16	-171	333	78	383	0.3427	174.04	11.762	0.1	0.1	1116.39	0.0764	29.90
40019	0.210	-37	72	16	-170	331	66	378	0.3386	169.92	10.128	0.1	0.1	1116.39	0.0764	29.90
40020	0.220	-39	76	17	-168	326	61	372	0.3333	164.61	9.381	0.1	0.1	1116.38	0.0764	29.90
40021	0.230	-40	79	17	-158	308	63	352	0.3156	147.59	10.277	0.1	0.1	1116.38	0.0764	29.90
40022	0.240	-42	82	19	-159	310	69	356	0.3184	150.29	11.223	0.1	0.1	1116.38	0.0764	29.90
40023	0.250	-43	85	19	-163	318	81	367	0.3284	159.82	12.791	0.1	0.1	1116.38	0.0764	29.90
40024	0.260	-45	88	20	-165	322	87	372	0.3333	164.66	13.442	0.1	0.1	1116.37	0.0764	29.90
40025	0.270	-47	91	21	-162	315	106	370	0.3311	162.42	16.730	0.1	0.1	1116.37	0.0764	29.90
40026	0.280	-49	95	22	-153	298	106	352	0.3152	147.26	17.527	0.1	0.2	1116.37	0.0764	29.90
40027	0.290	-50	97	23	-148	288	97	338	0.3028	135.86	16.603	0.1	0.2	1116.36	0.0764	29.90
40028	0.300	-51	100	24	-146	283	87	330	0.2957	129.59	15.219	0.1	0.2	1116.36	0.0764	29.90
40029	0.310	-53	103	25	-147	286	72	329	0.2947	128.67	12.588	0.1	0.2	1116.36	0.0764	29.90
40030	0.320	-54	106	26	-148	287	73	331	0.2964	130.20	12.810	0.1	0.2	1116.35	0.0764	29.89
40031	0.330	-56	109	26								0.1	0.2	1116.35	0.0764	29.89
40032	0.340															

TABLE E-1 (Cont.)

DATA SUMMARY TEST SKIN 2 DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.120	-29	-23	10								0.0	0.1	1116.41	0.0765	29.91
40002	0.130	-31	-24	10	-155	-121	81	213	0.1904	53.74	22.410	0.0	0.1	1116.41	0.0765	29.91
40003	0.140	-33	-25	11	-157	-138	75	222	0.1992	58.83	19.842	0.0	0.1	1116.41	0.0764	29.91
40004	0.150	-34	-27	12	-166	-132	76	226	0.2022	60.59	19.749	0.0	0.1	1116.40	0.0764	29.91
40005	0.160	-36	-28	12	-170	-130	78	228	0.2038	61.60	19.979	0.0	0.1	1116.40	0.0764	29.91
40006	0.170	-38	-29	13	-174	-117	82	225	0.2018	60.37	21.419	0.0	0.1	1116.40	0.0764	29.91
40007	0.180	-39	-30	14	-167	-116	84	220	0.1972	57.62	22.544	0.0	0.1	1116.40	0.0764	29.91
40008	0.190	-41	-31	15	-161	-127	72	217	0.1946	56.10	19.308	0.1	0.1	1116.39	0.0764	29.91
40009	0.200	-42	-33	16	-154	-128	70	212	0.1899	53.47	19.341	0.1	0.1	1116.39	0.0764	29.90
40010	0.210	-44	-34	16	-148	-132	65	208	0.1867	51.64	18.194	0.1	0.1	1116.39	0.0764	29.90
40011	0.220	-45	-35	17	-145	-126	67	203	0.1817	48.93	19.220	0.1	0.1	1116.38	0.0764	29.90
40012	0.230	-47	-37	18	-145	-128	69	206	0.1845	50.43	19.709	0.1	0.1	1116.38	0.0764	29.90
40013	0.240	-48	-38	18	-146	-129	67	206	0.1847	50.58	18.888	0.1	0.1	1116.38	0.0764	29.90
40014	0.250	-50	-39	19	-146	-135	72	211	0.1891	52.98	19.861	0.1	0.1	1116.38	0.0764	29.90
40015	0.260	-51	-41	20	-145	-134	73	211	0.1888	52.83	20.176	0.1	0.1	1116.37	0.0764	29.90
40016	0.270	-53	-42	21	-141	-128	69	203	0.1818	48.98	19.941	0.1	0.1	1116.37	0.0764	29.90
40017	0.280	-54	-43	21	-145	-118	66	198	0.1777	46.78	19.360	0.1	0.2	1116.37	0.0764	29.90
40018	0.290	-55	-44	22	-143	-112	64	193	0.1727	44.19	19.541	0.1	0.2	1116.37	0.0764	29.90
40019	0.300	-57	-45	22	-138	-122	65	195	0.1749	45.34	19.368	0.1	0.2	1116.36	0.0764	29.90
40020	0.310	-58	-47	23	-143	-121	66	199	0.1785	47.19	19.447	0.1	0.2	1116.36	0.0764	29.90
40021	0.320	-60	-48	24	-139	-123	66	197	0.1765	46.14	19.558	0.1	0.2	1116.36	0.0764	29.90
40022	0.330	-61	-49	25	-147	-115	63	197	0.1764	46.11	18.577	0.1	0.2	1116.36	0.0764	29.90
40023	0.340	-62	-50	25	-149	-118	60	200	0.1789	47.41	17.561	0.1	0.2	1116.35	0.0764	29.89
40024	0.350	-64	-51	26	-151	-116	57	199	0.1780	46.96	16.759	0.1	0.2	1116.35	0.0764	29.89
40025	0.360	-66	-53	26	-153	-119	52	201	0.1797	47.84	15.086	0.1	0.2	1116.35	0.0764	29.89
40026	0.370	-67	-54	27	-142	-121	51	193	0.1730	44.37	15.238	0.1	0.2	1116.35	0.0764	29.89
40027	0.380	-69	-55	27	-130	-119	58	186	0.1664	41.01	18.223	0.1	0.2	1116.35	0.0764	29.89
40028	0.390	-70	-56	28	-124	-122	54	182	0.1633	39.51	17.328	0.1	0.2	1116.34	0.0764	29.89
40029	0.400	-71	-57	29	-130	-117	62	185	0.1660	40.81	19.554	0.1	0.2	1116.34	0.0764	29.89
40030	0.410	-72	-58	29	-146	-107	61	191	0.1707	43.16	18.686	0.1	0.2	1116.34	0.0764	29.89
40031	0.420	-74	-60	30	-138	-110	47	183	0.1637	39.69	14.814	0.1	0.2	1116.34	0.0764	29.89
40032	0.430	-76	-60	30	-125	-116	49	177	0.1588	37.37	16.169	0.1	0.2	1116.33	0.0764	29.89
40033	0.440	-76	-62	30	-137	-112	47	183	0.1641	39.87	14.939	0.1	0.2	1116.33	0.0764	29.89
40034	0.450	-77	-63	31	-148	-114	50	193	0.1733	44.48	15.133	0.1	0.2	1116.33	0.0764	29.89
40035	0.460	-80	-64	32	-157	-106	54	197	0.1768	46.33	15.861	0.1	0.2	1116.33	0.0764	29.89

TABLE E-1 (Cont.)

DATA SUMMARY TEST SKIN 2 (Cont.)

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO.	PA
40036	0.470	-81	-65	32	-139	-104	42	179	0.1604	38.13	13.652	0.1	0.2	1116.33	0.0764	29.89
40037	0.480	-82	-66	32	-116	-103	37	160	0.1430	30.31	13.253	0.1	0.2	1116.33	0.0764	29.89
40038	0.490	-83	-67	33	-120	-102	42	163	0.1460	31.55	15.055	0.1	0.2	1116.32	0.0764	29.89
40039	0.500	-84	-68	33	-132	-105	47	175	0.1569	36.45	15.614	0.1	0.2	1116.32	0.0764	29.89
40040	0.510	-86	-69	34	-159	-109	47	198	0.1772	46.48	13.632	0.1	0.2	1116.32	0.0764	29.89
40041	0.520	-87	-70	34	-142	-124	46	194	0.1736	44.63	13.669	0.1	0.2	1116.32	0.0764	29.88
40042	0.530	-90	-71	35	-137	-116	38	184	0.1645	40.10	12.024	0.1	0.2	1116.32	0.0764	29.88
40043	0.540	-90	-73	35	-132	-108	30	173	0.1547	35.44	9.897	0.1	0.2	1116.32	0.0764	29.88
40044	0.550	-92	-74	35	-120	-97	28	157	0.1404	29.20	10.444	0.1	0.2	1116.31	0.0764	29.88
40045	0.560	-93	-75	36	-129	-87	22	157	0.1405	29.25	7.935	0.1	0.3	1116.31	0.0764	29.88
40046	0.570	-94	-76	36	-114	-99	37	155	0.1393	28.73	13.851	0.1	0.3	1116.31	0.0764	29.88
40047	0.580	-95	-77	36	-124	-98	50	166	0.1489	32.86	17.541	0.1	0.3	1116.31	0.0764	29.88
40048	0.590	-96	-78	37	-131	-104	51	174	0.1562	36.15	16.856	0.1	0.3	1116.31	0.0764	29.88
40049	0.600	-98	-78	37	-135	-99	49	174	0.1563	36.17	16.142	0.1	0.3	1116.31	0.0764	29.88
40050	0.610	-99	-80	38	-132	-100	33	169	0.1512	33.84	11.239	0.1	0.3	1116.31	0.0764	29.88
40051	0.620	-100	-80	38	-124	-97	30	160	0.1432	30.39	10.744	0.1	0.3	1116.30	0.0764	29.88
40052	0.630	-102	-82	38	-128	-86	32	158	0.1411	29.49	11.581	0.1	0.3	1116.30	0.0764	29.88
40053	0.640	-103	-82	39	-125	-76	31	149	0.1337	26.49	11.984	0.1	0.3	1116.30	0.0764	29.88
40054	0.650	-104	-83	39								0.1	0.3	1116.30	0.0764	29.88

TABLE E-1 (Cont.)

DATA SUMMARY TEST SKIN 3 DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.130	-17	-40	12								0.0	0.1	1116.41	0.0764	29.91
40002	0.140	-19	-43	12	-142	-271	78	316	0.2829	118.63	14.231	0.0	0.1	1116.40	0.0764	29.91
40003	0.150	-20	-46	13	-139	-258	84	305	0.2734	110.82	16.065	0.0	0.1	1116.40	0.0764	29.91
40004	0.160	-21	-48	14	-145	-263	88	313	0.2800	116.25	16.422	0.0	0.1	1116.40	0.0764	29.91
40005	0.170	-23	-51	15	-137	-261	81	305	0.2736	110.92	15.390	0.0	0.1	1116.39	0.0764	29.91
40006	0.180	-25	-54	16	-128	-263	85	304	0.2727	110.25	16.197	0.1	0.1	1116.39	0.0764	29.90
40007	0.190	-25	-56	16	-113	-258	98	299	0.2674	105.98	19.084	0.1	0.1	1116.39	0.0764	29.90
40008	0.200	-27	-59	18	-116	-237	96	281	0.2517	93.87	19.960	0.1	0.1	1116.38	0.0764	29.90
40009	0.210	-28	-61	19	-133	-232	99	285	0.2556	96.81	20.382	0.1	0.1	1116.38	0.0764	29.90
40010	0.220	-29	-63	19	-147	-223	86	280	0.2511	93.44	17.901	0.1	0.1	1116.38	0.0764	29.90
40011	0.230	-31	-65	20	-138	-231	80	281	0.2518	93.93	16.639	0.1	0.1	1116.37	0.0764	29.90
40012	0.240	-32	-68	21	-128	-242	79	285	0.2553	96.60	16.087	0.1	0.2	1116.37	0.0764	29.90
40013	0.250	-33	-70	22	-117	-233	73	271	0.2428	87.36	15.582	0.1	0.2	1116.37	0.0764	29.90
40014	0.260	-34	-73	23	-106	-231	76	266	0.2379	83.87	16.656	0.1	0.2	1116.36	0.0764	29.90
40015	0.270	-36	-75	23	-117	-225	77	265	0.2370	83.24	16.944	0.1	0.2	1116.36	0.0764	29.90
40016	0.280	-37	-77	24	-113	-236	77	273	0.2446	88.63	16.353	0.1	0.2	1116.36	0.0764	29.90
40017	0.290	-38	-79	25	-117	-240	73	277	0.2479	91.04	15.325	0.1	0.2	1116.35	0.0764	29.89
40018	0.300	-39	-82	26	-116	-228	69	265	0.2371	83.28	15.004	0.1	0.2	1116.35	0.0764	29.89
40019	0.310	-40	-84	26	-114	-219	72	257	0.2302	78.52	16.154	0.1	0.2	1116.35	0.0764	29.89
40020	0.320	-41	-86	27	-115	-223	75	262	0.2346	81.53	16.634	0.1	0.2	1116.35	0.0764	29.89
40021	0.330	-42	-88	28	-111	-229	80	267	0.2388	84.46	17.471	0.1	0.2	1116.34	0.0764	29.89
40022	0.340	-44	-91	29	-113	-231	87	272	0.2435	87.84	18.767	0.1	0.2	1116.34	0.0764	29.89
40023	0.350	-45	-93	30	-110	-227	86	267	0.2388	84.47	18.894	0.1	0.2	1116.34	0.0764	29.89
40024	0.360	-46	-95	31	-113	-228	81	267	0.2393	84.80	17.553	0.1	0.2	1116.33	0.0764	29.89
40025	0.370	-47	-98	31								0.1	0.2	1116.33	0.0764	29.89

TABLE E-1 (Cont.)

DATA SUMMARY TEST SKIN 4 OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.270	39	44	25								0.1	0.2	1116.35	0.0764	29.89
40002	0.280	40	45	26	91	102	60	150	0.1344	26.75	23.764	0.1	0.2	1116.35	0.0764	29.89
40003	0.290	41	46	27	117	131	19	177	0.1584	37.16	6.126	0.1	0.2	1116.35	0.0764	29.89
40004	0.300	42	47	27	116	130	16	175	0.1564	36.26	5.105	0.1	0.2	1116.35	0.0764	29.89
40005	0.310	44	49	26	106	118	53	167	0.1497	33.19	18.471	0.1	0.2	1116.35	0.0764	29.89
40006	0.320	44	49	27	93	104	82	162	0.1451	31.18	30.570	0.1	0.2	1116.35	0.0764	29.89
40007	0.330	45	50	29	78	88	108	160	0.1430	30.28	42.400	0.1	0.2	1116.34	0.0764	29.89
40008	0.340	46	51	30	93	104	80	161	0.1438	30.65	30.082	0.1	0.2	1116.34	0.0764	29.89
40009	0.350	47	53	30	83	93	62	139	0.1244	22.91	26.415	0.1	0.2	1116.33	0.0764	29.89
40010	0.360	48	54	31	73	82	78	135	0.1208	21.62	35.263	0.1	0.2	1116.33	0.0764	29.89
40011	0.370	48	54	32	73	81	79	135	0.1208	21.60	36.093	0.1	0.2	1116.33	0.0764	29.89
40012	0.380	49	55	33	73	82	66	128	0.1150	19.60	31.138	0.1	0.2	1116.32	0.0764	29.89
40013	0.390	50	56	33	84	95	46	135	0.1210	21.67	20.087	0.1	0.2	1116.32	0.0764	29.89
40014	0.400	51	57	33	83	93	36	130	0.1161	19.96	15.915	0.1	0.2	1116.32	0.0764	29.89
40015	0.410	52	58	34	70	79	47	116	0.1036	15.89	24.173	0.1	0.2	1116.32	0.0764	29.89
40016	0.420	52	59	34	59	66	64	109	0.0978	14.17	36.112	0.1	0.2	1116.32	0.0764	29.88
40017	0.430	53	59	35	49	54	73	103	0.0926	12.70	45.215	0.1	0.2	1116.32	0.0764	29.88
40018	0.440	53	59	36	65	73	68	119	0.1067	16.87	34.682	0.1	0.3	1116.31	0.0764	29.88
40019	0.450	54	60	36	85	95	61	142	0.1271	23.93	25.569	0.1	0.3	1116.31	0.0764	29.88
40020	0.460	55	62	37	95	106	56	153	0.1368	27.71	21.624	0.1	0.3	1116.31	0.0764	29.88
40021	0.470	56	63	38	92	103	55	148	0.1329	26.16	21.658	0.1	0.3	1116.31	0.0764	29.88
40022	0.480	57	63	38	80	90	55	132	0.1184	20.76	24.622	0.1	0.3	1116.30	0.0764	29.88
40023	0.490	57	64	39	79	88	53	130	0.1163	20.04	24.056	0.1	0.3	1116.30	0.0764	29.88
40024	0.500	58	65	39	78	87	52	128	0.1145	19.40	23.852	0.1	0.3	1116.30	0.0764	29.88
40025	0.510	59	66	40	77	86	51	126	0.1128	18.83	24.041	0.1	0.3	1116.30	0.0764	29.88
40026	0.520	60	67	40	76	86	51	126	0.1125	18.76	24.018	0.1	0.3	1116.30	0.0764	29.88
40027	0.530	60	68	41	75	84	51	124	0.1111	18.29	24.082	0.1	0.3	1116.29	0.0764	29.88
40028	0.540	61	69	41	73	82	51	121	0.1083	17.37	24.751	0.1	0.3	1116.29	0.0764	29.88
40029	0.550	62	70	42	69	78	51	116	0.1040	16.00	26.157	0.1	0.3	1116.29	0.0764	29.88
40030	0.560	63	70	42	64	72	52	110	0.0984	14.33	28.378	0.1	0.3	1116.29	0.0764	29.88
40031	0.570	63	71	43	58	64	54	102	0.0913	12.34	32.127	0.1	0.3	1116.29	0.0764	29.88
40032	0.580	64	72	43	54	60	55	97	0.0873	11.29	34.081	0.1	0.3	1116.28	0.0764	29.88
40033	0.590	64	72	44	54	60	53	97	0.0865	11.08	33.416	0.1	0.3	1116.28	0.0764	29.87
40034	0.600	65	73	44	57	64	50	99	0.0889	11.70	30.262	0.1	0.3	1116.28	0.0764	29.87
40035	0.610	65	73	45	66	74	43	108	0.0964	13.77	23.649	0.1	0.3	1116.28	0.0764	29.87
40036	0.620	66	74	45	69	77	40	111	0.0991	14.55	21.268	0.1	0.3	1116.28	0.0764	29.87
40037	0.630	67	75	46	69	77	40	111	0.0991	14.54	21.132	0.2	0.3	1116.28	0.0764	29.87
40038	0.640	68	76	46	66	74	42	107	0.0962	13.69	23.254	0.2	0.3	1116.27	0.0764	29.87
40039	0.650	68	76	46	62	69	50	105	0.0943	13.18	28.336	0.2	0.3	1116.27	0.0764	29.87
40040	0.660	69	77	47	59	66	53	103	0.0926	12.69	30.884	0.2	0.3	1116.27	0.0764	29.87
40041	0.670	69	78	48	55	61	53	98	0.0876	11.37	32.866	0.2	0.3	1116.27	0.0764	29.87
40042	0.680	70	78	48	49	54	50	88	0.0791	9.26	34.370	0.2	0.3	1116.27	0.0764	29.87
40043	0.690	70	79	49	41	46	44	75	0.0673	6.71	35.555	0.2	0.3	1116.26	0.0764	29.87
40044	0.700	71	79	49	30	33	39	59	0.0528	4.12	41.215	0.2	0.3	1116.26	0.0764	29.87
40045	0.710	71	80	49	24	27	35	50	0.0450	3.00	44.571	0.2	0.3	1116.26	0.0764	29.87
40046	0.720	71	80	50	25	27	33	50	0.0443	2.91	42.100	0.2	0.4	1116.26	0.0764	29.87
40047	0.730	71	80	50	31	35	33	57	0.0509	3.84	34.949	0.2	0.4	1116.26	0.0764	29.87
40048	0.740	72	81	50	47	53	33	78	0.0698	7.20	24.832	0.2	0.4	1116.26	0.0764	29.87
40049	0.750	72	81	51	53	59	32	85	0.0763	8.63	21.916	0.2	0.4	1116.26	0.0764	29.87
40050	0.760	73	82	51	52	58	31	84	0.0756	8.45	21.765	0.2	0.4	1116.25	0.0764	29.87
40051	0.770	73	82	51	46	51	31	75	0.0673	6.71	24.419	0.2	0.4	1116.25	0.0764	29.87
40052	0.780	74	83	52	30	33	33	55	0.0496	3.64	36.241	0.2	0.4	1116.25	0.0764	29.87
40053	0.790	74	83	52	23	25	33	47	0.0422	2.64	44.028	0.2	0.4	1116.25	0.0764	29.87
40054	0.800	74	83	52	20	23	31	43	0.0389	2.24	45.704	0.2	0.4	1116.25	0.0764	29.87
40055	0.810	74	83	53	23	26	28	44	0.0396	2.32	38.771	0.2	0.4	1116.25	0.0764	29.87
40056	0.820	75	84	53	30	34	23	51	0.0452	3.03	26.667	0.2	0.4	1116.25	0.0764	29.87
40057	0.830	75	84	53	35	39	17	55	0.0495	3.63	18.371	0.2	0.4	1116.25	0.0764	29.86
40058	0.840	75	85	53	38	42	14	59	0.0524	4.07	13.993	0.2	0.4	1116.25	0.0764	29.86
40059	0.850	76	85	53	39	43	13	59	0.0531	4.18	12.802	0.2	0.4	1116.25	0.0764	29.86
40060	0.860	76	85	53	37	42	14	58	0.0516	3.94	14.285	0.2	0.4	1116.25	0.0764	29.86
40061	0.870	77	86	54	34	38	15	54	0.0482	3.45	16.311	0.2	0.4	1116.24	0.0764	29.86
40062	0.880	77	86	54	34	38	16	53	0.0473	3.31	17.349	0.2	0.4	1116.24	0.0764	29.86
40063	0.890	77	87	54	33	36	18	52	0.0468	3.24	20.560	0.2	0.4	1116.24	0.0764	29.86
40064	0.900	78	87	54	32	35	23	53	0.0471	3.29	25.843	0.2	0.4	1116.24	0.0764	29.86
40065	0.910	78	87	54	31	34	35	58	0.0518	3.98	37.475	0.2	0.4	1116.24	0.0764	29.86
40066	0.920	78	88	55	30	33	41	60	0.0539	4.30	42.458	0.2	0.4	1116.24	0.0764	29.86
40067	0.930	78	88	55	28	32	39	58	0.0519	3.98	42.654	0.2	0.4	1116.24	0.0764	29.86
40068	0.940	79	88	56	27	30	31	51	0.0456	3.07	37.212	0.2	0.4	1116.24	0.0764	29.86
40069	0.950	79	89	56	26	28	16	41	0.0372	2.04	23.024	0.2	0.4	1116.24	0.0764	29.86
40070	0.960	79	89	56	24	27	2	36	0.0324	1.55	2.889	0.2	0.4	1116.24	0.0764	29.86
40071	0.970	79	89	56	23	25	-6	34	0.0309	1.41	-9.413	0.2	0.4	1116.24	0.0764	29.86
40072	0.980	80	89	56	21	24	-5	32	0.0288	1.23	-9.587	0.2	0.4	1116.24	0.0764	29.86
40073	0.990	80	90	56	20	22	2	29	0.0264	1.03	3.818	0.2	0.4	1116.24	0.0764	29.86
40074	1.000	80	90	56	17	19	17	30	0.0272	1.10	34.532	0.2	0.4	1116.24	0.0764	29.86
40075	1.010	80	90	56	15	17	23	32	0.0288	1.22	44.711	0.2	0.4	1116.24	0.0764	29.86
40076	1.020	80	90	56	15	17	24	33	0.0300	1.33	46.299	0.2	0.4	1116.23	0.0763	29.86
40077	1.030	81	90	57	17	19	22	34	0.0306	1.38	40.580	0.2	0.4	1116.23	0.0763	29.86
40078	1.040	81	91	57	20	22	17	35	0.0310	1.42	28.936	0.2	0.4	1116.23	0.0763	29.86
40079	1.050	81	91	57	22	24	15	36	0.0323	1.54	24.685	0.2	0.4	1116.23	0.0763	29.86
40080	1.060	81	91	57	24	26	14	38	0.0343	1.74	21.588	0.2	0.4	1116.23	0.0763	29.86
40081	1.070	81	91	57	26	29	14	41	0.0370	2.03	19.648	0.2	0.4	1116.23	0.0763	29.86
40082	1.080	82	92	57	29	33	14	46	0.0414	2.54	18.073	0.2	0.4	1116.23	0.0763	29.86
40083	1.090	82	92	57	32	35	14	50	0.0445	2.94	16.567	0.2	0.4	1116.23	0.0763	29.86
40084	1.100	82	92	58	33	37	14	52	0.0465	3.20	15.664	0.2	0.4	1116.23	0.0763	29.86
40085	1.110	83	93	58	34	38	14	53	0.0471	3.28	15.259	0.2	0.4	1116.23	0.0763	29.86
40086	1.120	83	93	58	33	37	14	52	0.0465	3.20	15.252	0.2	0.4	1116.23	0.0763	29.86
40087	1.130	83	94	58	35	39	16	55	0.0491	3.56	17.293	0.2	0.4	1116.23	0.0763	29.86
40088	1.140	84	94	58	35	39	16	55	0.0492	3.58	16.779	0.2	0.4	1116.23	0.0763	29.86
40089	1.150	84	94	58	34	38	12	52	0.0465	3.20	13.167	0.2	0.4	1116.23	0.0763	29.86
40090	1.160	84	95	58	31	34	4	46	0.0417	2.57	5.360	0.2	0.4	1116.23	0.0763	29.86
40091	1.170	85	95	58	25	27	-17	41	0.0363	1.95	-24.436	0.2	0.4	1116.23	0.0763	29.86
40092	1.180	85	95	58	22	24	-25	41	0.0367	2.00	-37.287	0.2	0.4	1116.23	0.0763	29.86
40093	1.190	85	95	58	22	24	-20	38	0.0342	1.73	-32.109	0.2	0.4	1116.23	0.0763	29.86
40094	1.200	85	96	58	24	27	-3	36	0.0324	1.55	-4.456	0.2	0.4	1116.23	0.0763	29.86
40095	1.210	86	96	58	32	35	40	62	0.0555	4.55	40.161	0.2	0.4	1116.23	0.0763	29.86
40096	1.220	86	96	58	35	39	61	80	0.0720	7.67	49.545	0.2	0.4	1116.23	0.0763	29.86
40097	1.230	86	97	59	35	39	67	85	0.0762	8.59	51.909	0.2	0.4	1116.22	0.0763	29.86
40098	1.240	87	97	60	32	36	56	74	0.0660	6.45	49.439	0.2	0.4	1116.22	0.0763	29.86
40099	1.250	87	98	60	26	29	30	49	0.0442	2.89	37.683	0.2	0.4	1116.22	0.0763	29.86
40100	1.260	87	98	60	20	22	9	31	0.0277	1.14	16.619	0.2	0.4	1116.22	0.0763	29.86

TABLE E-1 (Cont.)

DATA SUMMARY TEST SKIN 4 (Cont.)

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO.	PA
40101	1,270	87	98	61	17	18	-4	25	0,0225	0.75	-9.224	0.2	0.4	1116,22	0,0763	29,86
40102	1,280	87	98	60	17	19	-7	26	0,0233	0.81	-15.915	0.2	0.4	1116,22	0,0763	29,86
40103	1,290	88	98	60	20	22	-1	30	0,0271	1.09	-1.911	0.2	0.4	1116,22	0,0763	29,86
40104	1,300	88	99	60	29	33	15	46	0,0414	2.54	18.805	0.2	0.4	1116,22	0,0763	29,86
40105	1,310	88	99	60	32	36	20	52	0,0468	3.24	22.080	0.2	0.4	1116,22	0,0763	29,86
40106	1,320	89	99	61	32	35	21	52	0,0467	3.22	23.807	0.2	0.4	1116,22	0,0763	29,86
40107	1,330	89	100	61	28	31	19	46	0,0409	2.47	24.669	0.2	0.4	1116,22	0,0763	29,86
40108	1,340	89	100	61	16	17	16	28	0,0255	0.96	34.588	0.2	0.4	1116,22	0,0763	29,86
40109	1,350	89	100	61	11	12	15	21	0,0192	0.55	42.968	0.2	0.4	1116,22	0,0763	29,86
40110	1,360	89	100	61	11	12	11	19	0,0174	0.45	34.895	0.2	0.4	1116,21	0,0763	29,86
40111	1,370	89	100	61	17	18	6	25	0,0227	0.77	12.621	0.2	0.4	1116,21	0,0763	29,86
40112	1,380	90	101	61	27	31	-2	41	0,0369	2.01	-2.610	0.2	0.4	1116,21	0,0763	29,86
40113	1,390	90	101	61	40	44	-14	61	0,0545	4.40	-13.319	0.2	0.4	1116,21	0,0763	29,86
40114	1,400	90	101	61	45	51	-19	70	0,0630	5.88	-15.473	0.2	0.4	1116,21	0,0763	29,86
40115	1,410	91	102	61	44	49	-15	67	0,0602	5.37	-12.959	0.2	0.4	1116,22	0,0763	29,86
40116	1,420	91	103	61	35	39	-3	53	0,0475	3.34	-3.230	0.2	0.4	1116,22	0,0763	29,86
40117	1,430	92	103	61	18	20	21	34	0,0304	1.37	38.314	0.2	0.4	1116,22	0,0763	29,86
40118	1,440	92	103	61	11	12	31	35	0,0315	1.47	63.089	0.2	0.4	1116,22	0,0763	29,86
40119	1,450	92	103	62	8	9	33	35	0,0317	1.49	69.306	0.2	0.4	1116,21	0,0763	29,86
40120	1,460	92	103	62	11	12	26	31	0,0279	1.15	58.113	0.2	0.4	1116,21	0,0763	29,86
40121	1,470	92	103	62	18	20	11	29	0,0260	1.00	22.770	0.2	0.4	1116,21	0,0763	29,86
40122	1,480	92	103	62	20	23	5	31	0,0275	1.12	8.714	0.2	0.4	1116,21	0,0763	29,85
40123	1,490	92	104	62	22	25	0	34	0,0301	1.34	0.070	0.2	0.4	1116,21	0,0763	29,86
40124	1,500	93	104	62	24	27	-3	36	0,0325	1.56	-3.977	0.2	0.4	1116,21	0,0763	29,86
40125	1,510	93	104	62	26	29	-3	39	0,0346	1.77	-4.902	0.2	0.4	1116,21	0,0763	29,86
40126	1,520	93	105	62	30	33	-10	45	0,0406	2.44	-12.448	0.2	0.4	1116,21	0,0763	29,86
40127	1,530	94	105	62	31	34	-11	47	0,0425	2.68	-13.600	0.2	0.4	1116,21	0,0763	29,86
40128	1,540	94	105	62	29	32	-7	44	0,0395	2.31	-8.907	0.2	0.4	1116,21	0,0763	29,86
40129	1,550	94	106	62	25	27	3	37	0,0331	1.63	4.340	0.2	0.4	1116,21	0,0763	29,86
40130	1,560	94	106	62	14	15	24	32	0,0285	1.21	49.209	0.2	0.4	1116,21	0,0763	29,86
40131	1,570	95	106	62	10	11	32	36	0,0321	1.52	65.062	0.2	0.4	1116,21	0,0763	29,86
40132	1,580	94	106	63	12	13	31	36	0,0319	1.51	61.072	0.2	0.4	1116,21	0,0763	29,85
40133	1,590	95	106	63	18	20	20	34	0,0304	1.37	36.999	0.2	0.4	1116,21	0,0763	29,85
40134	1,600	95	106	63	36	40	-6	55	0,0489	3.53	-6.191	0.2	0.4	1116,21	0,0763	29,85
40135	1,610	95	107	63	44	49	-17	67	0,0605	5.41	-14.730	0.2	0.4	1116,21	0,0763	29,85
40136	1,620	96	108	62	43	48	-20	67	0,0599	5.31	-16.984	0.2	0.4	1116,21	0,0763	29,85
40137	1,630	96	108	62	33	37	-13	51	0,0460	3.13	-14.190	0.2	0.4	1116,21	0,0763	29,85
40138	1,640	97	108	62	16	18	2	25	0,0221	0.72	5.367	0.2	0.4	1116,21	0,0763	29,85
40139	1,650	97	108	62	6	7	10	14	0,0122	0.22	46.758	0.2	0.4	1116,21	0,0763	29,85
40140	1,660	97	108	63	-4	-4	18	19	0,0166	0.41	71.502	0.2	0.4	1116,21	0,0763	29,85
40141	1,670	97	108	63	-14	-16	25	33	0,0294	1.28	50.052	0.2	0.4	1116,21	0,0763	29,85
40142	1,680	96	108	63								0.2	0.4	1116,21	0,0763	29,85
40143	1,690															
40144	1,700															
40145	1,710															
40146	1,720															
40147	1,730	97	109	63								0.2	0.4	1116,21	0,0763	29,85
40148	1,740	97	109	63	20	22	-1	29	0,0262	1.02	-1.138	0.2	0.4	1116,21	0,0763	29,85
40149	1,750	97	109	63	20	22	-0	30	0,0267	1.05	-0.921	0.2	0.4	1116,21	0,0763	29,85
40150	1,760	98	110	63	20	23	-0	30	0,0272	1.09	-0.712	0.2	0.4	1116,21	0,0763	29,85
40151	1,770	98	110	63	21	23	-0	31	0,0276	1.13	-0.509	0.2	0.4	1116,21	0,0763	29,85
40152	1,780	98	110	63	21	23	-0	31	0,0281	1.17	-0.313	0.2	0.4	1116,21	0,0763	29,85
40153	1,790	98	110	63	21	24	-0	32	0,0286	1.21	-0.122	0.2	0.4	1116,21	0,0763	29,85
40154	1,800	99	110	63	22	24	0	32	0,0290	1.25	0.062	0.2	0.4	1116,21	0,0763	29,85
40155	1,810	99	111	63	22	24	0	33	0,0295	1.29	0.240	0.2	0.4	1116,21	0,0763	29,85
40156	1,820	99	111	63	22	25	0	33	0,0300	1.33	0.414	0.2	0.4	1116,21	0,0763	29,85
40157	1,830	99	111	63	23	25	0	34	0,0304	1.37	0.582	0.2	0.4	1116,21	0,0763	29,85
40158	1,840	99	111	63	24	26	2	36	0,0318	1.50	2.614	0.2	0.4	1116,21	0,0763	29,85
40159	1,850	100	112	63	24	27	2	36	0,0326	1.58	3.419	0.2	0.4	1116,21	0,0763	29,85
40160	1,860	100	112	63	24	27	2	37	0,0329	1.60	3.040	0.2	0.4	1116,21	0,0763	29,85
40161	1,870	100	112	63	24	27	1	36	0,0325	1.56	1.485	0.2	0.4	1116,21	0,0763	29,85
40162	1,880	100	113	63	24	26	-1	35	0,0316	1.48	-1.260	0.2	0.4	1116,21	0,0763	29,85
40163	1,890	101	113	63	24	26	-1	35	0,0317	1.48	-2.132	0.2	0.4	1116,21	0,0763	29,85
40164	1,900	101	113	63	24	26	-2	35	0,0317	1.48	-3.005	0.2	0.4	1116,21	0,0763	29,85
40165	1,910	101	113	63	24	26	-2	35	0,0317	1.49	-3.877	0.2	0.4	1116,21	0,0763	29,85
40166	1,920	101	114	63	24	26	-3	35	0,0318	1.49	-4.748	0.2	0.4	1116,21	0,0763	29,85
40167	1,930	102	114	63	23	26	-5	35	0,0318	1.49	-8.417	0.2	0.4	1116,21	0,0763	29,85
40168	1,940	102	114	63	23	26	-6	36	0,0319	1.50	-10.224	0.2	0.4	1116,21	0,0763	29,85
40169	1,950	102	114	63	23	26	-6	36	0,0319	1.51	-10.090	0.2	0.4	1116,21	0,0763	29,85
40170	1,960	102	115	63	24	26	-5	36	0,0320	1.52	-8.095	0.2	0.4	1116,21	0,0763	29,85
40171	1,970	103	115	63	24	27	-3	36	0,0322	1.53	-4.484	0.2	0.4	1116,21	0,0763	29,85
40172	1,980	103	115	63	24	27	-2	36	0,0323	1.54	-3.789	0.2	0.4	1116,21	0,0763	29,85
40173	1,990	103	116	63	24	27	-2	36	0,0324	1.55	-3.098	0.2	0.4	1116,21	0,0763	29,85
40174	2,000	103	116	63	24	27	-2	36	0,0325	1.56	-2.412	0.2	0.4	1116,21	0,0763	29,85
40175	2,010	104	116	63	26	29	-0	40	0,0355	1.86	-0.387	0.2	0.4	1116,21	0,0763	29,85
40176	2,020	104	116	63	27	31	1	41	0,0368	2.01	0.703	0.2	0.4	1116,21	0,0763	29,85
40177	2,030	104	117	63	27	30	1	40	0,0363	1.95	1.039	0.2	0.4	1116,21	0,0763	29,85
40178	2,040	104	117	63	25	28	0	38	0,0338	1.69	0.627	0.2	0.4	1116,21	0,0763	29,85
40179	2,050	105	117	63	22	25	-0	33	0,0296	1.30	-0.731	0.2	0.4	1116,21	0,0763	29,85
40180	2,060	105	118	63	21	23	-0	31	0,0282	1.18	-0.806	0.2	0.4	1116,21	0,0763	29,85
40181	2,070	105	118	63	20	22	-0	30	0,0268	1.06	-0.888	0.2	0.4	1116,21	0,0763	29,85
40182	2,080	105	118	63	19	21	-0	28	0,0254	0.95	-0.979	0.2	0.4	1116,21	0,0763	29,85
40183	2,090	105	118	63	18	20	-1	27	0,0239	0.85	-1.082	0.2	0.4	1116,21	0,0763	29,85
40184	2,100	106	118	63	14	16	-1	21	0,0191	0.54	-2.022	0.2	0.4	1116,21	0,0763	29,85
40185	2,110	106	119	63	12	14	-1	18	0,0164	0.40	-2.682	0.2	0.4	1116,21	0,0763	29,85
40186	2,120	106	119	63	12	13	-1	18	0,0160	0.38	-2.589	0.2	0.4	1116,21	0,0763	29,85
40187	2,130	106	119	63	13	15	-1	20	0,0179	0.47	-1.741	0.2	0.4	1116,21	0,0763	29,85
40188	2,140	106	119	63	16	18	-0	24	0,0219	0.71	-0.639	0.2	0.4	1116,21	0,0763	29,85
40189	2,150	106	119	63	17	19	-0	25	0,0224	0.74	-0.386	0.2	0.4	1116,21	0,0763	29,85
40190	2,160	106	119	63	17	19	-0	25	0,0228	0.77	-0.143	0.2	0.4	1116,21	0,0763	29,85
40191	2,170	107	120	63	17	19	0	26	0,0233	0.80	0.090	0.2	0.4	1116,21	0,0763	29,85
40192	2,180	107	120	63	18	20	0	27	0,0245	0.89	0.679	0.2	0.4	1116,21	0,0763	29,85
40193	2,190	107	120	63	19	21	1	28	0,0252	0.94	1.030	0.2	0.4	1116,21	0,0763	29,85
40194	2,200	107	120	63	19	21	1	29	0,0256	0.97	1.156	0.2	0.4	1116,21	0,0763	29,85
40195	2,210	107	120	63	19	21	1	28	0,0255	0.96	1.064	0.2	0.4	1116,21	0,0763	29,85
40196	2,220	108	121	63	19	21	0	28	0,0249	0.92	0.757	0.2	0.4	1116,21	0,0763	29,85
40197	2,230	108	121	63	19	21	0	28	0,0250	0.93	0.772	0.2	0.4	1116,21	0,0763	29,85
40198	2,240	108	121	63	19	21	0	28	0,0252	0.94	0.787	0.2	0.4	1116,21	0,0763	29,85
40199	2,250	108	121	63	19	21	0	28	0,0253	0.94	0.802	0.2	0.4	1116,21	0,0763	29,85
40200	2,260	108	121	63	19	21	0	28	0,0254	0.95	0.817	0.2	0.4	1116,21	0,0763	29,85
40201	2,270	108	122	63	19	21	-0	29	0,0256	0.97	-0.031	0.2	0.4	1116,21	0,0763	29,85
40202	2,280	109	122	63	19	21	-1	29	0,0258	0.98	-1.603	0.2	0.4	1116,21	0,0763	29,85
40203	2,290	109	122	63	19	21	-1	29	0,0259	0.99	-1.125	0.2	0.4	1116,21	0,0763	29,85
40204	2,300	109	122	63	19	21	0	29	0,0258	0.99	0.504	0.2	0.4	1116,21	0,0763	29,85
40205	2,310	109	123	63	19	21	2	29	0,0258	0.99	3.200	0.2	0.4	1116,21	0,0763	29,85
40206	2,320	109	123	63	19	21	2	29	0,0259	0.99	4.160	0.2	0.4	1116,21	0,0763	29,85
40207	2,330	110	123	63	19	21	3	29	0,0260	1.00	5.125	0.2	0.4	1116,21	0,0763	29,85
40208	2,340	110	123	63	19	21	3	29	0,0260	1.00	6.076	0.2	0.4	1116,21	0,0763	29,85
40209	2,350	110	123	63	19	22	4	29	0,0261	1.01	7.021	0.2	0.4	1116,21	0,0763	29,85
40210	2,360	110	124	63	19	22	4	29	0,0262	1.02	7.961	0.2	0.4	1116,21	0,0763	29,85
40211	2,370	110	124	63	19	22	5	29	0,0263	1.03	8.895	0.2	0.4	1116,21	0,0763	29,85
40212	2,380	111	124	63	19	22	5	30	0,0265	1.04	9.821	0.2	0.4	1116,21	0,0763	29,85
40213	2,390	111	124	63	20	22	6	30	0,0266	1.05	10.741	0.2	0.4	1116,21	0,0763	29,85
40214	2,400	111	125	63	20	22	6	30	0,0267	1.06	11.652	0.2	0.4	1116,21	0,0763	29,85
40215	2,410	111	125	63								0.2	0.4	1116,21	0,0763	29,85

TABLE E-1 (Cont.)

DATA SUMMARY TEST SKIN 5 OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.090	28	0	8								0.0	0.1	1116.42	0.0765	29.91
40002	0.100	31	0	9	271	-0	97	288	0.2578	98.56	19.621	0.0	0.1	1116.41	0.0765	29.91
40003	0.110	34	0	10	290	-0	91	304	0.2725	110.05	17.333	0.0	0.1	1116.41	0.0765	29.91
40004	0.120	37	0	11	291	-0	78	301	0.2700	108.09	15.052	0.0	0.1	1116.41	0.0764	29.91
40005	0.130	40	0	12	278	-0	87	291	0.2605	100.60	17.339	0.0	0.1	1116.41	0.0764	29.91
40006	0.140	42	0	12	270	-0	81	282	0.2527	94.64	16.699	0.0	0.1	1116.40	0.0764	29.91
40007	0.150	45	0	14	274	-0	88	288	0.2580	98.65	17.817	0.0	0.1	1116.40	0.0764	29.91
40008	0.160	48	0	14	273	-0	91	287	0.2575	98.27	18.407	0.0	0.1	1116.40	0.0764	29.91
40009	0.170	51	0	15	279	-0	77	289	0.2588	99.30	15.368	0.0	0.1	1116.39	0.0764	29.91
40010	0.180	53	0	16	269	-0	82	281	0.2519	94.02	16.857	0.1	0.1	1116.39	0.0764	29.90
40011	0.190	56	0	17	270	-0	83	282	0.2528	94.74	17.019	0.1	0.1	1116.39	0.0764	29.90
40012	0.200	59	0	18	266	-0	82	278	0.2493	92.10	17.173	0.1	0.1	1116.38	0.0764	29.90
40013	0.210	61	0	19	255	-0	88	269	0.2413	86.30	19.097	0.1	0.1	1116.38	0.0764	29.90
40014	0.220	64	0	19	246	-0	86	260	0.2329	80.39	19.202	0.1	0.1	1116.38	0.0764	29.90
40015	0.230	66	0	20	247	-0	80	259	0.2322	79.94	18.056	0.1	0.1	1116.37	0.0764	29.90
40016	0.240	69	0	21	248	-0	76	259	0.2323	79.95	17.084	0.1	0.1	1116.37	0.0764	29.90
40017	0.250	71	0	22	252	-0	73	263	0.2353	82.02	16.211	0.1	0.2	1116.37	0.0764	29.90
40018	0.260	74	0	22	251	-0	66	260	0.2327	80.26	14.746	0.1	0.2	1116.36	0.0764	29.90
40019	0.270	76	0	23	239	-0	81	252	0.2258	75.54	18.630	0.1	0.2	1116.36	0.0764	29.90
40020	0.280	79	0	24	240	-0	77	252	0.2255	75.37	17.908	0.1	0.2	1116.36	0.0764	29.90
40021	0.290	81	0	25	243	-0	74	254	0.2272	76.51	16.856	0.1	0.2	1116.35	0.0764	29.89
40022	0.300	83	0	25	243	-0	79	255	0.2285	77.39	17.931	0.1	0.2	1116.35	0.0764	29.89
40023	0.310	86	0	26	239	-0	71	249	0.2231	73.72	16.572	0.1	0.2	1116.35	0.0764	29.89
40024	0.320	88	0	27	228	-0	80	242	0.2168	69.65	19.343	0.1	0.2	1116.35	0.0764	29.89
40025	0.330	90	0	28	225	-0	68	235	0.2102	65.48	16.813	0.1	0.2	1116.34	0.0764	29.89
40026	0.340	93	0	28	233	-0	57	240	0.2150	68.50	13.763	0.1	0.2	1116.34	0.0764	29.89
40027	0.350	95	0	29	236	-0	58	243	0.2176	70.14	13.832	0.1	0.2	1116.34	0.0764	29.89
40028	0.360	98	0	29	234	-0	62	242	0.2167	69.58	14.802	0.1	0.2	1116.34	0.0764	29.89
40029	0.370	100	0	30	227	-0	71	238	0.2132	67.34	17.321	0.1	0.2	1116.33	0.0764	29.89
40030	0.380	102	0	31	218	-0	66	228	0.2039	61.57	16.783	0.1	0.2	1116.33	0.0764	29.89
40031	0.390	104	0	32	218	-0	59	226	0.2022	60.54	15.102	0.1	0.2	1116.33	0.0764	29.89
40032	0.400	106	0	32	219	-0	57	227	0.2030	61.02	14.638	0.1	0.2	1116.33	0.0764	29.89
40033	0.410	108	0	32	224	-0	62	232	0.2082	64.22	15.585	0.1	0.2	1116.33	0.0764	29.89
40034	0.420	111	0	33	224	-0	60	232	0.2074	63.70	15.032	0.1	0.2	1116.32	0.0764	29.89
40035	0.430	113	0	34	219	-0	63	228	0.2046	62.01	16.120	0.1	0.2	1116.32	0.0764	29.89
40036	0.440	115	0	34	215	-0	54	221	0.1982	58.18	14.133	0.1	0.2	1116.32	0.0764	29.88
40037	0.450	117	0	35	212	-0	55	219	0.1965	57.16	14.397	0.1	0.2	1116.32	0.0764	29.88
40038	0.460	119	0	35	211	-0	60	220	0.1969	57.40	15.972	0.1	0.3	1116.31	0.0764	29.88
40039	0.470	122	0	36	209	-0	54	216	0.1932	55.28	14.438	0.1	0.3	1116.31	0.0764	29.88
40040	0.480	124	0	37	206	-0	54	213	0.1912	54.12	14.619	0.1	0.3	1116.31	0.0764	29.88
40041	0.490	126	0	37	206	-0	54	213	0.1907	53.88	14.652	0.1	0.3	1116.31	0.0764	29.88
40042	0.500	128	0	38	205	-0	62	214	0.1918	54.48	16.843	0.1	0.3	1116.31	0.0764	29.88
40043	0.510	130	0	38	202	-0	65	212	0.1903	53.61	17.690	0.1	0.3	1116.30	0.0764	29.88
40044	0.520	132	0	39	198	-0	59	207	0.1850	50.69	16.675	0.1	0.3	1116.30	0.0764	29.88
40045	0.530	134	0	40								0.1	0.3	1116.30	0.0764	29.88

TABLE E-2

DATA SUMMARY TEST NORTH JET OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.060	0	25	2								0.0	0.0	1116.44	0.0765	29.92
40002	0.070	0	31	2	-0	471	72	477	0.4270	270.38	8.664	0.0	0.0	1116.44	0.0765	29.92
40003	0.080	0	35	3	-0	424	61	428	0.3837	218.35	8.220	0.0	0.0	1116.44	0.0765	29.92
40004	0.090	0	38	3	-0	397	59	401	0.3594	191.54	8.447	0.0	0.0	1116.44	0.0765	29.92
40005	0.100	0	43	4	-0	376	57	380	0.3407	172.14	8.656	0.0	0.0	1116.43	0.0765	29.92
40006	0.110	0	47	5	-0	364	63	369	0.3307	162.17	9.755	0.0	0.0	1116.43	0.0765	29.92
40007	0.120	0	49	5	-0	366	52	370	0.3314	162.80	8.041	0.0	0.0	1116.43	0.0765	29.92
40008	0.130	0	53	6	-0	361	54	366	0.3274	158.94	8.529	0.0	0.0	1116.43	0.0765	29.91
40009	0.140	0	58	6	-0	373	50	376	0.3370	168.34	7.661	0.0	0.0	1116.43	0.0765	29.91
40010	0.150	0	61	7	-0	358	54	362	0.3239	155.51	8.584	0.0	0.0	1116.42	0.0765	29.91
40011	0.160	0	64	7	-0	347	68	353	0.3164	148.40	11.086	0.0	0.1	1116.42	0.0765	29.91
40012	0.170	0	68	8	-0	361	72	368	0.3299	161.31	11.317	0.0	0.1	1116.42	0.0765	29.91
40013	0.180	0	71	9	-0	377	63	382	0.3424	173.80	9.490	0.0	0.1	1116.42	0.0765	29.91
40014	0.190	0	75	10	-0	361	46	364	0.3263	157.83	7.279	0.0	0.1	1116.41	0.0765	29.91
40015	0.200	0	80	10	-0	348	38	350	0.3139	146.07	6.205	0.0	0.1	1116.41	0.0765	29.91
40016	0.210	0	82	10	-0	337	38	339	0.3034	136.49	6.504	0.0	0.1	1116.41	0.0765	29.91
40017	0.220	0	85	11	-0	329	45	332	0.2973	131.04	7.765	0.0	0.1	1116.41	0.0765	29.91
40018	0.230	0	89	11	-0	355	37	357	0.3197	151.50	6.017	0.0	0.1	1116.41	0.0764	29.91
40019	0.240	0	92	11	-0	360	36	362	0.3241	155.76	5.640	0.0	0.1	1116.41	0.0764	29.91
40020	0.250	0	96	12	-0	350	46	353	0.3158	147.88	7.531	0.0	0.1	1116.41	0.0764	29.91
40021	0.260	0	100	12	-0	356	38	358	0.3204	152.15	6.143	0.0	0.1	1116.40	0.0764	29.91
40022	0.270	0	103	13	-0	356	28	357	0.3196	151.46	4.446	0.0	0.1	1116.40	0.0764	29.91
40023	0.280	0	107	13	-0	348	5	348	0.3119	144.21	0.812	0.0	0.1	1116.40	0.0764	29.91
40024	0.290	0	110	13	-0	366	18	366	0.3280	159.45	2.888	0.0	0.1	1116.40	0.0764	29.91
40025	0.300	0	113	13	-0	361	23	362	0.3244	155.96	3.690	0.0	0.1	1116.40	0.0764	29.91
40026	0.310	0	118	14	-0	349	10	349	0.3130	145.20	1.668	0.0	0.1	1116.40	0.0764	29.91
40027	0.320	0	121	13	-0	325	2	325	0.2913	125.80	0.354	0.0	0.1	1116.40	0.0764	29.91
40028	0.330	0	124	13	-0	294	-27	295	0.2646	103.77	-5.304	0.0	0.1	1116.40	0.0764	29.91
40029	0.340	0	127	13	-0	282	-9	282	0.2525	94.51	-1.758	0.0	0.1	1116.40	0.0764	29.91
40030	0.350	0	130	13	-0	298	-10	298	0.2667	105.41	-2.007	0.0	0.1	1116.40	0.0764	29.91
40031	0.360	0	133	13								0.0	0.1	1116.40	0.0764	29.91

TABLE E-2 (Cont.)

DATA SUMMARY TEST SOUTH JET OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.100	0	-39	5								0.0	0.0	1116.43	0.0765	29.92
40002	0.110	0	-44	4	-0	-412	-10	412	0.3688	201.67	-1.441	0.0	0.0	1116.43	0.0765	29.92
40003	0.120	0	-48	5								0.0	0.0	1116.43	0.0765	29.92
40004	0.130															
40005	0.140															
40006	0.150															
40007	0.160	0	-60	3								0.0	0.0	1116.44	0.0765	29.92
40008	0.170	0	-63	3	-0	-240	41	243	0.2177	70.29	9.702	0.0	0.0	1116.44	0.0765	29.92
40009	0.180	0	-65	4	-0	-241	21	242	0.2171	69.89	4.974	0.0	0.0	1116.44	0.0765	29.92
40010	0.190	0	-67	3	-0	-235	25	237	0.2119	66.61	6.101	0.0	0.0	1116.44	0.0765	29.92
40011	0.200	0	-70	4	-0	-221	19	222	0.1988	58.62	4.854	0.0	0.0	1116.43	0.0765	29.92
40012	0.210	0	-72	4	-0	-182	12	182	0.1633	39.56	3.823	0.0	0.0	1116.43	0.0765	29.92
40013	0.220	0	-74	4	-0	-127	-22	129	0.1158	19.88	-9.577	0.0	0.0	1116.43	0.0765	29.92
40014	0.230	0	-75	4	-0	-117	-9	118	0.1054	16.47	-4.418	0.0	0.0	1116.44	0.0765	29.92
40015	0.240	0	-75	3	-0	-125	0	125	0.1116	18.46	0.177	0.0	0.0	1116.44	0.0765	29.92
40016	0.250	0	-77	5	-0	-149	29	151	0.1357	27.30	10.997	0.0	0.0	1116.43	0.0765	29.92
40017	0.260	0	-79	4	-0	-161	54	170	0.1518	34.19	18.450	0.0	0.0	1116.44	0.0765	29.92
40018	0.270	0	-80	5	-0	-122	39	128	0.1146	19.48	17.602	0.0	0.0	1116.43	0.0765	29.92
40019	0.280	0	-82	6	-0	-97	36	104	0.0927	12.75	20.554	0.0	0.0	1116.43	0.0765	29.92
40020	0.290	0	-82	6	-0	-86	-1	86	0.0770	8.80	-0.809	0.0	0.0	1116.43	0.0765	29.92
40021	0.300	0	-83	6	-0	-106	-4	106	0.0948	13.33	-2.061	0.0	0.0	1116.43	0.0765	29.92
40022	0.310	0	-84	5	-0	-145	17	146	0.1307	25.33	6.735	0.0	0.0	1116.43	0.0765	29.92
40023	0.320	0	-86	6	-0	-161	49	168	0.1509	33.75	16.835	0.0	0.0	1116.43	0.0765	29.92
40024	0.330	0	-87	6	-0	-174	69	187	0.1678	41.76	21.745	0.0	0.0	1116.43	0.0765	29.91
40025	0.340	0	-89	7	-0	-163	51	171	0.1534	34.88	17.476	0.0	0.1	1116.42	0.0765	29.91
40026	0.350	0	-91	8	-0	-176	51	183	0.1641	39.91	16.263	0.0	0.1	1116.42	0.0765	29.91
40027	0.360	0	-92	8	-0	-183	9	183	0.1638	39.80	2.942	0.0	0.1	1116.42	0.0765	29.91
40028	0.370	0	-95	9	-0	-171	-1	171	0.1531	34.76	-0.258	0.0	0.1	1116.42	0.0765	29.91
40029	0.380	0	-96	7	-0	-175	4	175	0.1564	36.26	1.237	0.0	0.1	1116.42	0.0765	29.91
40030	0.390	0	-97	8	-0	-155	47	162	0.1451	31.22	16.869	0.0	0.1	1116.42	0.0765	29.91
40031	0.400	0	-99	8								0.0	0.1	1116.42	0.0765	29.91

TABLE E-2 (Cont.)

DATA SUMMARY TEST EAST JET OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.090	36	0	2								0.0	0.0	1116.44	0.0765	29.92
40002	0.100	40	0	3	383	-0	13	384	0.3437	175.12	1.968	0.0	0.0	1116.44	0.0765	29.92
40003	0.110	43	0	3	373	-0	46	376	0.3367	168.14	7.077	0.0	0.0	1116.44	0.0765	29.92
40004	0.120	47	0	4	373	-0	52	376	0.3371	168.49	7.972	0.0	0.0	1116.44	0.0765	29.92
40005	0.130	51	0	4	382	-0	49	385	0.3445	176.01	7.276	0.0	0.0	1116.43	0.0765	29.92
40006	0.140	55	0	4	377	-0	36	378	0.3390	170.41	5.466	0.0	0.0	1116.43	0.0765	29.92
40007	0.150	59	0	5	364	-0	35	365	0.3271	158.64	5.471	0.0	0.0	1116.43	0.0765	29.92
40008	0.160	62	0	5	352	-0	39	354	0.3172	149.20	6.287	0.0	0.0	1116.43	0.0765	29.92
40009	0.170	65	0	6	348	-0	43	351	0.3141	146.29	7.062	0.0	0.0	1116.43	0.0765	29.92
40010	0.180	69	0	6	340	-0	41	343	0.3071	139.80	6.946	0.0	0.0	1116.43	0.0765	29.91
40011	0.190	73	0	7	331	-0	50	335	0.3001	133.54	8.549	0.0	0.0	1116.43	0.0765	29.91
40012	0.200	76	0	7	332	-0	48	335	0.3001	133.53	8.216	0.0	0.0	1116.42	0.0765	29.91
40013	0.210	79	0	8	341	-0	46	344	0.3078	140.47	7.671	0.0	0.1	1116.42	0.0765	29.91
40014	0.220	83	0	8	350	-0	43	353	0.3158	147.90	7.069	0.0	0.1	1116.42	0.0765	29.91
40015	0.230	86	0	8	342	-0	28	344	0.3077	140.40	4.614	0.0	0.1	1116.42	0.0765	29.91
40016	0.240	89	0	9	324	-0	29	325	0.2912	125.73	5.051	0.0	0.1	1116.42	0.0765	29.91
40017	0.250	92	0	9	294	-0	19	295	0.2639	103.24	3.727	0.0	0.1	1116.42	0.0765	29.91
40018	0.260	96	0	9	286	-0	16	287	0.2570	97.90	3.197	0.0	0.1	1116.42	0.0765	29.91
40019	0.270	98	0	9	276	-0	24	277	0.2483	91.44	5.034	0.0	0.1	1116.42	0.0765	29.91
40020	0.280	101	0	9	287	-0	33	289	0.2584	99.01	6.586	0.0	0.1	1116.42	0.0765	29.91
40021	0.290	103	0	10	303	-0	45	306	0.2744	111.61	8.457	0.0	0.1	1116.41	0.0765	29.91
40022	0.300	107	0	10	308	-0	42	311	0.2784	114.93	7.792	0.0	0.1	1116.41	0.0765	29.91
40023	0.310	110	0	11	310	-0	30	312	0.2793	115.66	5.450	0.0	0.1	1116.41	0.0765	29.91
40024	0.320	113	0	11	303	-0	21	304	0.2720	109.67	4.006	0.0	0.1	1116.41	0.0765	29.91
40025	0.330	116	0	11	284	-0	16	285	0.2551	96.44	3.220	0.0	0.1	1116.41	0.0764	29.91
40026	0.340	119	0	11	261	-0	21	262	0.2346	81.58	4.706	0.0	0.1	1116.41	0.0764	29.91
40027	0.350	121	0	11	245	-0	19	246	0.2199	71.71	4.430	0.0	0.1	1116.41	0.0764	29.91
40028	0.360	124	0	12	228	-0	15	229	0.2050	62.30	3.735	0.0	0.1	1116.41	0.0764	29.91
40029	0.370	126	0	12	231	-0	11	231	0.2067	63.35	2.667	0.0	0.1	1116.41	0.0764	29.91
40030	0.380	128	0	12	220	-0	8	220	0.1972	57.66	1.974	0.0	0.1	1116.41	0.0764	29.91
40031	0.390	130	0	12	206	-0	15	206	0.1847	50.56	4.230	0.0	0.1	1116.40	0.0764	29.91
40032	0.400	132	0	12								0.0	0.1	1116.40	0.0764	29.91

TABLE E-2 (Cont.)

DATA SUMMARY TEST WEST   JET   OPTICL DATA   RUN NO 1   UNSMOOTHED TRAJECTORY

PLANE DATA   FRAME NO.   00000- 39999   UNIT DATA   FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.090	-34	-0	3								0.0	0.0	1116.44	0.0765	29.92
40002	0.100	-38	-0	4	-374	-0	53	378	0.3384	169.81	8.087	0.0	0.0	1116.44	0.0765	29.92
40003	0.110	-42	-0	4	-367	-0	56	371	0.3324	163.83	8.755	0.0	0.0	1116.43	0.0765	29.92
40004	0.120	-45	-0	5	-369	-0	62	374	0.3353	166.70	9.594	0.0	0.0	1116.43	0.0765	29.92
40005	0.130	-49	-0	5	-376	-0	56	380	0.3404	171.82	8.546	0.0	0.0	1116.43	0.0765	29.92
40006	0.140	-53	-0	6	-384	-0	55	388	0.3476	179.19	8.210	0.0	0.0	1116.43	0.0765	29.91
40007	0.150	-57	-0	6	-379	-0	55	383	0.3429	174.37	8.273	0.0	0.0	1116.43	0.0765	29.91
40008	0.160	-61	-0	7	-378	-0	54	382	0.3420	173.44	8.155	0.0	0.1	1116.42	0.0765	29.91
40009	0.170	-64	-0	8	-398	-0	58	402	0.3599	192.07	8.282	0.0	0.1	1116.42	0.0765	29.91
40010	0.180	-68	-0	8	-343	-0	41	345	0.3093	141.84	6.846	0.0	0.1	1116.42	0.0765	29.91
40011	0.190	-73	-0	9	-250	-0	26	252	0.2256	75.43	5.924	0.0	0.1	1116.42	0.0765	29.91
40012	0.200	-74	-0	9	-158	-0	10	159	0.1422	29.97	3.520	0.0	0.1	1116.42	0.0765	29.91
40013	0.210	-74	-0	9	-103	-0	3	103	0.0925	12.68	1.441	0.0	0.1	1116.42	0.0765	29.91
40014	0.220	-75	-0	9	-127	-0	2	127	0.1142	19.32	0.845	0.0	0.1	1116.42	0.0765	29.91
40015	0.230	-77	-0	9	-166	-0	1	166	0.1489	32.86	0.206	0.0	0.1	1116.42	0.0765	29.91
40016	0.240	-78	-0	9	-213	-0	4	213	0.1908	53.99	1.164	0.0	0.1	1116.42	0.0765	29.91
40017	0.250	-81	-0	9	-239	-0	10	239	0.2140	67.00	2.390	0.0	0.1	1116.42	0.0765	29.91
40018	0.260	-84	-0	9	-237	-0	7	237	0.2120	66.65	1.592	0.0	0.1	1116.42	0.0765	29.91
40019	0.270	-86	-0	9	-209	-0	2	209	0.1876	52.16	0.429	0.0	0.1	1116.42	0.0765	29.91
40020	0.280	-88	-0	9	-182	-0	-5	182	0.1633	39.54	-1.596	0.0	0.1	1116.42	0.0765	29.91
40021	0.290	-90	-0	9	-180	-0	-6	180	0.1614	38.62	-1.818	0.0	0.1	1116.42	0.0765	29.91
40022	0.300	-92	-0	9	-189	-0	1	189	0.1689	42.31	0.157	0.0	0.1	1116.42	0.0765	29.91
40023	0.310	-93	-0	9	-186	-0	-14	186	0.1669	41.32	-4.174	0.0	0.1	1116.42	0.0765	29.91
40024	0.320	-95	-0	9	-169	-0	-23	171	0.1531	34.73	-7.690	0.0	0.1	1116.42	0.0765	29.91
40025	0.330	-97	-0	8	-160	-0	-25	162	0.1449	31.13	-8.785	0.0	0.1	1116.42	0.0765	29.91
40026	0.340	-98	-0	8	-136	-0	-19	137	0.1231	22.47	-7.969	0.0	0.1	1116.42	0.0765	29.91
40027	0.350	-100	-0	8	-149	-0	-6	149	0.1337	26.49	-2.258	0.0	0.1	1116.42	0.0765	29.91
40028	0.360	-101	-0	8	-161	-0	-8	161	0.1442	30.85	-2.864	0.0	0.1	1116.42	0.0765	29.91
40029	0.370	-103	-0	8	-167	-0	-22	168	0.1509	33.75	-7.624	0.0	0.1	1116.42	0.0765	29.91
40030	0.380	-104	-0	8	-164	-0	-24	166	0.1486	32.76	-8.424	0.0	0.1	1116.42	0.0765	29.91
40031	0.390	-106	-0	7	-145	-0	-25	147	0.1317	25.71	-9.671	0.0	0.1	1116.42	0.0765	29.91
40032	0.400	-107	-0	7	-138	-0	-20	140	0.1253	23.27	-8.047	0.0	0.1	1116.42	0.0765	29.91
40033	0.410	-109	-0	7	-126	-0	-9	126	0.1131	18.97	-4.063	0.0	0.0	1116.42	0.0765	29.91
40034	0.420	-110	-0	7	-138	-0	-9	138	0.1239	22.77	-3.809	0.0	0.0	1116.42	0.0765	29.91
40035	0.430	-111	-0	7	-140	-0	-3	140	0.1258	23.48	-1.044	0.0	0.0	1116.42	0.0765	29.91
40036	0.440	-113	-0	7	-142	-0	-1	142	0.1272	23.97	-0.468	0.0	0.0	1116.42	0.0765	29.91
40037	0.450	-114	-0	7	-126	-0	-1	126	0.1125	18.77	-0.468	0.0	0.0	1116.42	0.0765	29.91
40038	0.460	-116	-0	7	-108	-0	-1	108	0.0971	13.99	-0.468	0.0	0.0	1116.42	0.0765	29.91
40039	0.470	-116	-0	7	-103	-0	-1	103	0.0923	12.62	-0.468	0.0	0.0	1116.42	0.0765	29.91
40040	0.480	-118	-0	7	-115	-0	1	115	0.1026	15.61	0.383	0.0	0.0	1116.42	0.0765	29.91
40041	0.490	-119	-0	7	-119	-0	-15	120	0.1072	17.03	-7.198	0.0	0.0	1116.42	0.0765	29.91
40042	0.500	-120	-0	7	-120	-0	-24	122	0.1097	17.85	-11.401	0.0	0.0	1116.42	0.0765	29.91
40043	0.510	-121	-0	6	-118	-0	-25	120	0.1079	17.27	-12.210	0.0	0.0	1116.43	0.0765	29.91
40044	0.520	-122	-0	6	-112	-0	-19	113	0.1014	15.23	-9.580	0.0	0.0	1116.43	0.0765	29.91
40045	0.530	-123	-0	6	-111	-0	-2	111	0.0997	14.74	-0.924	0.0	0.0	1116.43	0.0765	29.91
40046	0.540	-125	-0	6	-102	-0	-1	102	0.0914	12.38	-0.454	0.0	0.0	1116.43	0.0765	29.91
40047	0.550	-125	-0	6	-92	-0	-1	92	0.0822	10.03	-0.467	0.0	0.0	1116.43	0.0765	29.91
40048	0.560	-126	-0	6	-82	-0	-1	82	0.0731	7.91	-0.467	0.0	0.0	1116.43	0.0765	29.91
40049	0.570	-127	-0	6	-72	-0	-1	72	0.0648	6.22	-0.870	0.0	0.0	1116.43	0.0765	29.91
40050	0.580	-128	-0	6	-69	-0	4	69	0.0617	5.64	3.327	0.0	0.0	1116.43	0.0765	29.91
40051	0.590	-128	-0	6	-68	-0	7	68	0.0613	5.57	5.962	0.0	0.0	1116.43	0.0765	29.92
40052	0.600	-129	-0	6	-59	-0	8	60	0.0536	4.26	7.347	0.0	0.0	1116.43	0.0765	29.91
40053	0.610	-130	-0	6	-57	-0	6	57	0.0515	3.93	5.599	0.0	0.0	1116.43	0.0765	29.91
40054	0.620	-130	-0	6	-59	-0	1	59	0.0531	4.18	0.810	0.0	0.0	1116.43	0.0765	29.91
40055	0.630	-131	-0	6	-77	-0	1	77	0.0687	6.99	1.085	0.0	0.0	1116.43	0.0765	29.91
40056	0.640	-132	-0	6								0.0	0.0	1116.43	0.0765	29.91

TABLE E-3

DATA SUMMARY TEST VERT JET DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.040	1	-0	27								0.1	0.2	1116.35	0.0764	29.89
40002	0.050	1	0	32	4	32	523	524	0.4697	326.79	86.473	0.1	0.2	1116.33	0.0764	29.89
40003	0.060	1	0	37	-13	14	588	588	0.5271	411.49	88.160	0.1	0.3	1116.31	0.0764	29.88
40004	0.070	0	0	44	-17	1	613	613	0.5493	446.69	88.446	0.1	0.3	1116.28	0.0764	29.87
40005	0.080	0	0	50	-2	-3	625	625	0.5602	464.63	89.667	0.2	0.4	1116.26	0.0764	29.87
40006	0.090	0	0	56	3	-3	612	612	0.5478	444.22	89.576	0.2	0.4	1116.23	0.0763	29.86
40007	0.100	1	0	62	-1	-5	601	602	0.5389	429.71	89.548	0.2	0.4	1116.21	0.0763	29.85
40008	0.110	0	0	69	-5	-4	598	598	0.5354	424.07	89.363	0.2	0.5	1116.19	0.0763	29.85
40009	0.120	0	0	74	-12	-5	593	593	0.5315	417.86	88.729	0.2	0.5	1116.16	0.0763	29.84
40010	0.130	0	0	80	-7	3	586	586	0.5253	408.11	89.263	0.3	0.6	1116.14	0.0763	29.84
40011	0.140	-0	0	86	-8	9	585	585	0.5245	406.71	88.823	0.3	0.6	1116.12	0.0763	29.83
40012	0.150	-0	0	92	-7	6	582	582	0.5215	402.04	89.073	0.3	0.6	1116.10	0.0763	29.82
40013	0.160	-0	0	98	-7	0	570	570	0.5104	384.94	89.335	0.3	0.7	1116.07	0.0763	29.82
40014	0.170	-0	0	104	-10	-1	559	559	0.5009	370.77	88.981	0.3	0.7	1116.05	0.0762	29.81
40015	0.180	-0	0	109	-18	-4	552	552	0.4950	361.98	88.128	0.4	0.8	1116.03	0.0762	29.81
40016	0.190	-1	0	114	-19	-2	553	553	0.4958	363.03	88.025	0.4	0.8	1116.01	0.0762	29.80
40017	0.200	-1	0	120	-15	-2	557	557	0.4990	367.75	88.466	0.4	0.8	1115.99	0.0762	29.79
40018	0.210	-1	0	126	-7	-3	550	550	0.4930	358.77	89.176	0.4	0.9	1115.97	0.0762	29.79
40019	0.220	-1	0	131	-3	2	534	534	0.4785	337.90	89.615	0.4	0.9	1115.95	0.0762	29.78
40020	0.230	-1	0	136								0.4	1.0	1115.93	0.0762	29.78

TABLE E-3 (Cont.)

DATA SUMMARY TEST NOSE 1 OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	16.150	33	113	174								0.6	1.2	1115.78	0.0761	29.74
40002	16.160	32	112	173	-20	-68	-108	129	0.1160	19.82	-56.702	0.6	1.2	1115.79	0.0761	29.74
40003	16.170	32	112	172	-3	-10	-92	92	0.0829	10.12	-83.225	0.6	1.2	1115.79	0.0761	29.74
40004	16.180	32	113	171	2	7	-89	90	0.0804	9.53	-85.686	0.6	1.2	1115.79	0.0761	29.74
40005	16.190	32	113	170	0	2	-95	95	0.0848	10.60	-89.047	0.6	1.2	1115.80	0.0761	29.74
40006	16.200	32	112	169	-7	-22	-106	109	0.0974	13.99	-77.646	0.6	1.2	1115.80	0.0761	29.74
40007	16.210	32	112	168	-11	-37	-117	123	0.1102	17.92	-71.729	0.6	1.2	1115.81	0.0761	29.74
40008	16.220	32	112	167	-12	-42	-122	129	0.1160	19.85	-70.126	0.6	1.2	1115.81	0.0761	29.74
40009	16.230	32	111	165	-11	-37	-120	126	0.1131	18.86	-72.408	0.5	1.2	1115.82	0.0761	29.75
40010	16.240	32	111	164	-6	-21	-113	115	0.1028	15.59	-79.198	0.5	1.2	1115.82	0.0761	29.75
40011	16.250	32	111	163	3	10	-95	95	0.0856	10.80	-83.752	0.5	1.2	1115.82	0.0761	29.75
40012	16.260	32	111	162	7	25	-88	92	0.0820	9.92	-73.381	0.5	1.1	1115.83	0.0761	29.75
40013	16.270	32	112	161	9	33	-87	93	0.0834	10.27	-68.321	0.5	1.1	1115.83	0.0761	29.75
40014	16.280	32	112	161	9	33	-92	98	0.0878	11.37	-69.233	0.5	1.1	1115.83	0.0761	29.75
40015	16.290	32	112	160	8	27	-102	106	0.0950	13.30	-74.483	0.5	1.1	1115.84	0.0761	29.75
40016	16.300	32	112	159	8	27	-113	116	0.1043	16.05	-75.813	0.5	1.1	1115.84	0.0761	29.75
40017	16.310	32	113	157	8	28	-118	121	0.1085	17.37	-76.328	0.5	1.1	1115.85	0.0761	29.75
40018	16.320	33	113	156	8	28	-116	119	0.1068	16.82	-76.103	0.5	1.1	1115.85	0.0761	29.76
40019	16.330	33	113	155	8	27	-107	111	0.0995	14.59	-75.106	0.5	1.1	1115.85	0.0761	29.76
40020	16.340	33	114	154	8	29	-89	94	0.0844	10.51	-71.531	0.5	1.1	1115.86	0.0761	29.76
40021	16.350	33	114	153	8	29	-81	87	0.0778	8.92	-69.768	0.5	1.1	1115.86	0.0761	29.76
40022	16.360	33	114	152	8	28	-78	84	0.0749	8.27	-69.974	0.5	1.1	1115.86	0.0761	29.76
40023	16.370	33	115	152	7	25	-81	85	0.0758	8.47	-72.420	0.5	1.1	1115.87	0.0761	29.76
40024	16.380	33	115	151	6	20	-87	90	0.0803	9.52	-76.399	0.5	1.1	1115.87	0.0761	29.76
40025	16.390	33	115	150	5	18	-87	89	0.0801	9.47	-78.115	0.5	1.1	1115.87	0.0761	29.76
40026	16.400	33	115	149	4	15	-90	91	0.0817	9.85	-80.365	0.5	1.1	1115.88	0.0761	29.76
40027	16.410	33	115	148	3	11	-95	95	0.0855	10.77	-83.037	0.5	1.0	1115.88	0.0761	29.76
40028	16.420	33	115	147	2	7	-102	102	0.0913	12.30	-85.864	0.5	1.0	1115.88	0.0761	29.76
40029	16.430	33	115	146	-1	-1	-117	117	0.1049	16.24	-89.367	0.5	1.0	1115.89	0.0762	29.77
40030	16.440	33	115	145	-2	-6	-125	125	0.1118	18.44	-87.228	0.5	1.0	1115.89	0.0762	29.77
40031	16.450	33	115	143	-2	-6	-125	125	0.1120	18.50	-87.046	0.5	1.0	1115.90	0.0762	29.77
40032	16.460	33	115	142	-1	-2	-117	117	0.1052	16.34	-88.842	0.5	1.0	1115.90	0.0762	29.77
40033	16.470	33	115	141	1	5	-104	104	0.0930	12.76	-86.962	0.5	1.0	1115.91	0.0762	29.77
40034	16.480	33	115	140	3	11	-91	92	0.0822	9.97	-82.618	0.5	1.0	1115.91	0.0762	29.77
40035	16.490	33	115	139	4	15	-84	86	0.0768	8.70	-79.500	0.5	1.0	1115.92	0.0762	29.77
40036	16.500	33	116	139	4	16	-84	86	0.0769	8.74	-78.817	0.5	1.0	1115.92	0.0762	29.77
40037	16.510	33	116	138	4	15	-90	92	0.0822	9.97	-80.540	0.5	1.0	1115.92	0.0762	29.77
40038	16.520	33	116	137	3	10	-106	106	0.0953	13.41	-84.286	0.5	1.0	1115.92	0.0762	29.78
40039	16.530	33	116	136	2	9	-111	112	0.1001	14.79	-85.135	0.4	1.0	1115.93	0.0762	29.78
40040	16.540	33	116	134	2	9	-112	112	0.1006	14.92	-85.194	0.4	0.9	1115.93	0.0762	29.78
40041	16.550	33	116	133	3	10	-107	108	0.0966	13.77	-84.461	0.4	0.9	1115.94	0.0762	29.78
40042	16.560	33	116	132	3	12	-98	99	0.0889	11.68	-82.877	0.4	0.9	1115.94	0.0762	29.78
40043	16.570	34	117	131	4	15	-91	92	0.0828	10.12	-80.334	0.4	0.9	1115.95	0.0762	29.78
40044	16.580	34	117	130	4	16	-87	88	0.0793	9.28	-79.454	0.4	0.9	1115.95	0.0762	29.78
40045	16.590	34	117	130	4	14	-87	88	0.0787	9.14	-80.802	0.4	0.9	1115.95	0.0762	29.78
40046	16.600	34	117	129	2	9	-90	90	0.0809	9.67	-84.140	0.4	0.9	1115.96	0.0762	29.78
40047	16.610	34	117	128	-0	-1	-96	96	0.0858	10.86	-89.311	0.4	0.9	1115.96	0.0762	29.79
40048	16.620	34	117	127	-2	-6	-98	98	0.0880	11.42	-86.607	0.4	0.9	1115.96	0.0762	29.79
40049	16.630	34	117	126	-2	-6	-100	100	0.0899	11.93	-86.254	0.4	0.9	1115.97	0.0762	29.79
40050	16.640	34	117	125	-1	-3	-102	102	0.0915	12.35	-88.151	0.4	0.9	1115.97	0.0762	29.79

TABLE E-3 (Cont.)

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO.	PA
40051	16.650	34	117	124	1	3	-104	104	0.0931	12.80	-88.162	0.4	0.9	1115.97	0.0762	29.79
40052	16.660	34	117	123	1	3	-109	109	0.0980	14.18	-88.421	0.4	0.9	1115.98	0.0762	29.79
40053	16.670	34	117	122	2	7	-111	111	0.0994	14.60	-86.505	0.4	0.9	1115.98	0.0762	29.79
40054	16.680	34	117	120	4	15	-108	109	0.0974	14.01	-82.017	0.4	0.9	1115.99	0.0762	29.79
40055	16.690	34	117	119	8	27	-100	104	0.0932	12.84	-74.573	0.4	0.8	1115.99	0.0762	29.79
40056	16.700	34	118	119	15	51	-84	100	0.0893	11.79	-57.833	0.4	0.8	1115.99	0.0762	29.80
40057	16.710	34	118	118	18	63	-78	102	0.0912	12.28	-49.646	0.4	0.8	1116.00	0.0762	29.80
40058	16.720	34	119	117	19	65	-77	103	0.0920	12.50	-48.446	0.4	0.8	1116.00	0.0762	29.80
40059	16.730	34	120	116	16	57	-82	102	0.0910	12.23	-54.141	0.4	0.8	1116.00	0.0762	29.80
40060	16.740	35	120	115	11	40	-93	102	0.0913	12.31	-65.765	0.4	0.8	1116.01	0.0762	29.80
40061	16.750	35	121	114	9	32	-102	107	0.0962	13.68	-71.822	0.4	0.8	1116.01	0.0762	29.80
40062	16.760	35	121	113	7	24	-107	109	0.0981	14.21	-76.744	0.4	0.8	1116.01	0.0762	29.80
40063	16.770	35	121	112	4	16	-106	107	0.0960	13.62	-81.086	0.4	0.8	1116.02	0.0762	29.80
40064	16.780	35	121	111	2	8	-100	101	0.0903	12.04	-85.424	0.4	0.8	1116.02	0.0762	29.80
40065	16.790	35	121	110	-4	-13	-87	88	0.0790	9.21	-81.183	0.4	0.8	1116.03	0.0762	29.80
40066	16.800	35	121	109	-7	-23	-82	86	0.0767	8.69	-74.042	0.4	0.8	1116.03	0.0762	29.80
40067	16.810	35	120	109	-5	-18	-82	85	0.0759	8.50	-76.836	0.4	0.8	1116.03	0.0762	29.81
40068	16.820	35	120	108	-0	-1	-88	88	0.0785	9.10	-89.624	0.4	0.8	1116.04	0.0762	29.81
40069	16.830	35	121	107	8	29	-97	101	0.0909	12.21	-72.715	0.4	0.8	1116.04	0.0762	29.81
40070	16.840	35	121	106	17	59	-103	120	0.1079	17.19	-59.223	0.3	0.7	1116.04	0.0762	29.81
40071	16.850	35	122	105	21	74	-108	133	0.1192	21.00	-54.520	0.3	0.7	1116.05	0.0762	29.81
40072	16.860	35	123	104	21	72	-111	134	0.1204	21.42	-55.073	0.3	0.7	1116.05	0.0762	29.81
40073	16.870	36	123	103	16	55	-113	126	0.1131	18.89	-63.191	0.3	0.7	1116.06	0.0762	29.81
40074	16.880	36	124	101	5	17	-116	117	0.1050	16.30	-81.563	0.3	0.7	1116.06	0.0762	29.81
40075	16.890	36	124	100	1	2	-118	118	0.1056	16.49	-88.869	0.3	0.7	1116.06	0.0763	29.81
40076	16.900	36	124	99	-1	-2	-116	116	0.1039	15.95	-89.162	0.3	0.7	1116.07	0.0763	29.82
40077	16.910	36	124	98	1	5	-110	110	0.0988	14.43	-87.273	0.3	0.7	1116.07	0.0763	29.82
40078	16.920	36	124	97	6	20	-101	103	0.0927	12.71	-78.177	0.3	0.7	1116.08	0.0763	29.82
40079	16.930	36	124	96	8	27	-93	97	0.0868	11.13	-73.211	0.3	0.7	1116.08	0.0763	29.82
40080	16.940	36	124	95	9	33	-88	94	0.0846	10.57	-68.707	0.3	0.7	1116.09	0.0763	29.82
40081	16.950	36	125	94	11	39	-87	96	0.0861	10.95	-65.369	0.3	0.7	1116.09	0.0763	29.82
40082	16.960	36	125	93	12	44	-91	101	0.0908	12.18	-63.409	0.3	0.7	1116.09	0.0763	29.82
40083	16.970	36	126	92	16	54	-98	113	0.1012	15.13	-59.944	0.3	0.7	1116.10	0.0763	29.82
40084	16.980	36	126	91	17	60	-100	118	0.1058	16.53	-57.962	0.3	0.6	1116.10	0.0763	29.82
40085	16.990	37	127	90	17	59	-101	118	0.1061	16.64	-58.602	0.3	0.6	1116.10	0.0763	29.83
40086	17.000	37	128	89	15	52	-101	114	0.1023	15.48	-61.927	0.3	0.6	1116.11	0.0763	29.83
40087	17.010	37	128	88	11	39	-99	107	0.0960	13.63	-68.050	0.3	0.6	1116.11	0.0763	29.83
40088	17.020	37	128	87	7	25	-100	103	0.0926	12.68	-75.711	0.3	0.6	1116.11	0.0763	29.83
40089	17.030	37	129	86	5	19	-100	102	0.0909	12.23	-78.851	0.3	0.6	1116.12	0.0763	29.83
40090	17.040	37	129	85	6	22	-98	100	0.0899	11.94	-76.570	0.3	0.6	1116.12	0.0763	29.83
40091	17.050	37	129	84	10	34	-94	101	0.0903	12.05	-69.263	0.3	0.6	1116.13	0.0763	29.83
40092	17.060	37	129	83	18	63	-90	111	0.0997	14.70	-53.850	0.3	0.6	1116.13	0.0763	29.83
40093	17.070	37	130	83	21	73	-87	116	0.1037	15.92	-48.715	0.3	0.6	1116.13	0.0763	29.83
40094	17.080	38	131	82	20	71	-84	112	0.1006	14.98	-48.642	0.3	0.6	1116.14	0.0763	29.83
40095	17.090	38	132	81	16	57	-82	101	0.0904	12.08	-54.134	0.3	0.6	1116.14	0.0763	29.84
40096	17.100	38	132	80	6	23	-75	79	0.0703	7.32	-72.629	0.3	0.6	1116.14	0.0763	29.84
40097	17.110	38	132	79	2	6	-71	71	0.0638	6.02	-84.945	0.3	0.6	1116.15	0.0763	29.84
40098	17.120	38	132	79	-0	-1	-71	71	0.0639	6.03	-89.253	0.3	0.6	1116.15	0.0763	29.84
40099	17.130	38	132	78	1	3	-76	76	0.0684	6.92	-87.893	0.3	0.6	1116.15	0.0763	29.84
40100	17.140	38	132	77	4	16	-86	87	0.0781	9.02	-79.128	0.3	0.5	1116.15	0.0763	29.84

TABLE E-3 (Cont.)

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO.	PA
40101	17.150	38	132	76	7	23	-94	97	0.0873	11.27	-75.665	0.3	0.5	1116.16	0.0763	29.84
40102	17.160	38	133	75	8	29	-100	105	0.0939	13.04	-73.461	0.2	0.5	1116.16	0.0763	29.84
40103	17.170	38	133	74	9	32	-103	108	0.0971	13.94	-72.196	0.2	0.5	1116.17	0.0763	29.84
40104	17.180	38	133	73	9	33	-103	108	0.0968	13.87	-71.640	0.2	0.5	1116.17	0.0763	29.84
40105	17.190	38	134	72	9	30	-99	104	0.0932	12.86	-72.464	0.2	0.5	1116.17	0.0763	29.84
40106	17.200	39	134	71	9	31	-99	104	0.0932	12.84	-72.067	0.2	0.5	1116.18	0.0763	29.85
40107	17.210	39	134	70	9	33	-99	104	0.0936	12.96	-70.808	0.2	0.5	1116.18	0.0763	29.85
40108	17.220	39	135	69	11	37	-98	106	0.0947	13.28	-68.645	0.2	0.5	1116.18	0.0763	29.85
40109	17.230	39	135	68	12	43	-98	108	0.0967	13.83	-65.745	0.2	0.5	1116.19	0.0763	29.85
40110	17.240	39	136	67	13	47	-100	111	0.0993	14.59	-63.868	0.2	0.5	1116.19	0.0763	29.85
40111	17.250	39	136	66	15	51	-99	113	0.1011	15.12	-61.809	0.2	0.5	1116.20	0.0763	29.85
40112	17.260	39	137	65	16	56	-98	114	0.1019	15.37	-59.464	0.2	0.5	1116.20	0.0763	29.85
40113	17.270	39	137	64	17	60	-95	114	0.1019	15.35	-56.774	0.2	0.5	1116.20	0.0763	29.85
40114	17.280	40	138	63	20	71	-88	114	0.1026	15.56	-50.050	0.2	0.4	1116.21	0.0763	29.85
40115	17.290	40	138	62	22	77	-84	116	0.1040	15.99	-46.482	0.2	0.4	1116.21	0.0763	29.85
40116	17.300	40	139	62	22	76	-84	116	0.1036	15.88	-46.530	0.2	0.4	1116.21	0.0763	29.86
40117	17.310	40	140	61	20	69	-87	113	0.1013	15.19	-50.584	0.2	0.4	1116.22	0.0763	29.86
40118	17.320	40	141	60	16	55	-94	110	0.0987	14.43	-58.589	0.2	0.4	1116.22	0.0763	29.86
40119	17.330	41	141	59	12	41	-100	109	0.0977	14.13	-66.880	0.2	0.4	1116.22	0.0763	29.86
40120	17.340	41	142	58	9	32	-104	110	0.0982	14.26	-72.087	0.2	0.4	1116.23	0.0763	29.86
40121	17.350	41	142	57	9	30	-105	110	0.0986	14.37	-73.490	0.2	0.4	1116.23	0.0763	29.86
40122	17.360	41	142	56	10	34	-104	110	0.0984	14.33	-71.199	0.2	0.4	1116.24	0.0764	29.86
40123	17.370	41	143	55	14	47	-100	112	0.1001	14.82	-63.788	0.2	0.4	1116.24	0.0764	29.86
40124	17.380	41	143	54	15	52	-99	113	0.1010	15.10	-61.412	0.2	0.4	1116.24	0.0764	29.86
40125	17.390	41	144	53	15	52	-98	112	0.1002	14.86	-61.150	0.2	0.4	1116.25	0.0764	29.87
40126	17.400	41	144	52	13	47	-97	109	0.0974	14.05	-63.217	0.2	0.4	1116.25	0.0764	29.87
40127	17.410	42	145	51	11	38	-96	104	0.0933	12.88	-67.661	0.2	0.4	1116.25	0.0764	29.87
40128	17.420	42	145	50	8	29	-95	99	0.0888	11.68	-72.571	0.2	0.4	1116.26	0.0764	29.87
40129	17.430	42	145	49	7	23	-94	97	0.0866	11.10	-75.657	0.2	0.3	1116.26	0.0764	29.87
40130	17.440	42	145	48	6	22	-94	96	0.0864	11.05	-76.121	0.2	0.3	1116.27	0.0764	29.87
40131	17.450	42	146	47	7	26	-94	98	0.0881	11.48	-73.959	0.2	0.3	1116.27	0.0764	29.87
40132	17.460	42	146	46	10	35	-97	103	0.0926	12.69	-69.158	0.2	0.3	1116.27	0.0764	29.87
40133	17.470	42	146	45	11	39	-98	106	0.0946	13.26	-67.362	0.1	0.3	1116.28	0.0764	29.87
40134	17.480	42	147	44	12	41	-98	107	0.0958	13.58	-66.392	0.1	0.3	1116.28	0.0764	29.87
40135	17.490	42	147	43	12	41	-98	107	0.0958	13.58	-66.245	0.1	0.3	1116.28	0.0764	29.88
40136	17.500	42	148	42	11	40	-97	106	0.0948	13.31	-66.824	0.1	0.3	1116.29	0.0764	29.88
40137	17.510	43	148	41	12	43	-96	106	0.0950	13.35	-65.274	0.1	0.3	1116.29	0.0764	29.88
40138	17.520	43	148	40	12	43	-96	106	0.0949	13.33	-65.201	0.1	0.3	1116.30	0.0764	29.88
40139	17.530	43	149	39	11	40	-97	105	0.0944	13.21	-66.893	0.1	0.3	1116.30	0.0764	29.88
40140	17.540	43	149	38	10	34	-99	105	0.0940	13.07	-70.338	0.1	0.3	1116.30	0.0764	29.88
40141	17.550	43	149	37	6	20	-101	103	0.0925	12.67	-78.564	0.1	0.3	1116.31	0.0764	29.88
40142	17.560	43	150	36	4	13	-103	104	0.0928	12.76	-82.664	0.1	0.3	1116.31	0.0764	29.88
40143	17.570	43	150	35	3	12	-104	105	0.0942	13.16	-83.179	0.1	0.2	1116.31	0.0764	29.88
40144	17.580	43	150	34	5	18	-106	108	0.0967	13.84	-80.012	0.1	0.2	1116.32	0.0764	29.88
40145	17.590	43	150	33	9	30	-108	113	0.1009	15.07	-73.975	0.1	0.2	1116.32	0.0764	29.89
40146	17.600	43	150	32	10	34	-115	120	0.1075	17.11	-72.827	0.1	0.2	1116.33	0.0764	29.89
40147	17.610	43	151	31	12	41	-117	124	0.1111	18.29	-70.008	0.1	0.2	1116.33	0.0764	29.89
40148	17.620	43	151	30	14	50	-113	125	0.1117	18.49	-65.105	0.1	0.2	1116.34	0.0764	29.89
40149	17.630	44	152	29	18	63	-105	123	0.1106	18.12	-57.874	0.1	0.2	1116.34	0.0764	29.89
40150	17.640	44	152	28	22	78	-92	123	0.1099	17.90	-48.545	0.1	0.2	1116.34	0.0764	29.89
40151	17.650	44	153	27	26	90	-84	126	0.1131	18.96	-41.826	0.1	0.2	1116.35	0.0764	29.89
40152	17.660	44	154	26	30	103	-76	132	0.1179	20.59	-35.530	0.1	0.2	1116.35	0.0764	29.89
40153	17.670	45	155	25	33	115	-69	138	0.1240	22.78	-29.793	0.1	0.2	1116.35	0.0764	29.89
40154	17.680	45	157	25								0.1	0.2	1116.36	0.0764	29.90

TABLE E-3 (Cont.)

DATA SUMMARY TEST RING 1 DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	8.800	-36	67	128								0.4	0.9	1115.96	0.0762	29.78
40002	8.810	-36	67	127	-5	13	-83	84	0.0754	8.39	-80.298	0.4	0.9	1115.96	0.0762	29.79
40003	8.820	-36	67	127	-2	12	-81	82	0.0735	7.97	-81.314	0.4	0.9	1115.96	0.0762	29.79
40004	8.830	-36	67	126	-0	11	-79	80	0.0717	7.59	-82.132	0.4	0.9	1115.97	0.0762	29.79
40005	8.840	-36	67	125	2	10	-77	78	0.0699	7.22	-82.626	0.4	0.9	1115.97	0.0762	29.79
40006	8.850	-36	67	124	6	8	-74	75	0.0668	6.59	-82.209	0.4	0.9	1115.97	0.0762	29.79
40007	8.860	-36	68	123	8	7	-72	73	0.0653	6.30	-81.525	0.4	0.9	1115.98	0.0762	29.79
40008	8.870	-36	68	123	9	6	-72	73	0.0655	6.33	-81.515	0.4	0.9	1115.98	0.0762	29.79
40009	8.880	-36	68	122	8	6	-74	75	0.0673	6.69	-82.420	0.4	0.9	1115.98	0.0762	29.79
40010	8.890	-36	68	121	6	6	-78	79	0.0706	7.37	-83.652	0.4	0.9	1115.98	0.0762	29.79
40011	8.900	-36	68	121	6	6	-80	81	0.0723	7.71	-84.228	0.4	0.9	1115.99	0.0762	29.79
40012	8.910	-36	68	120	5	5	-82	82	0.0737	8.02	-84.981	0.4	0.8	1115.99	0.0762	29.79
40013	8.920	-36	68	119	4	5	-83	84	0.0749	8.28	-85.898	0.4	0.8	1115.99	0.0762	29.79
40014	8.930	-36	68	118	2	4	-85	85	0.0765	8.64	-87.179	0.4	0.8	1116.00	0.0762	29.80
40015	8.940	-36	68	117	1	3	-86	86	0.0774	8.85	-87.981	0.4	0.8	1116.00	0.0762	29.80
40016	8.950	-36	68	116	-0	3	-87	87	0.0781	9.02	-88.157	0.4	0.8	1116.00	0.0762	29.80
40017	8.960	-36	68	115	-2	3	-88	88	0.0787	9.15	-87.331	0.4	0.8	1116.01	0.0762	29.80
40018	8.970	-36	68	115	-4	5	-88	88	0.0793	9.28	-85.815	0.4	0.8	1116.01	0.0762	29.80
40019	8.980	-36	68	114	-11	6	-92	93	0.0833	10.25	-82.586	0.4	0.8	1116.01	0.0762	29.80
40020	8.990	-36	68	113	-13	6	-94	95	0.0850	10.68	-81.090	0.4	0.8	1116.02	0.0762	29.80
40021	9.000	-36	68	112	-12	7	-93	94	0.0840	10.42	-81.787	0.4	0.8	1116.02	0.0762	29.80
40022	9.010	-36	68	111	-5	7	-89	90	0.0803	9.51	-84.390	0.4	0.8	1116.02	0.0762	29.80
40023	9.020	-36	68	110	5	7	-84	84	0.0753	8.37	-84.067	0.4	0.8	1116.03	0.0762	29.80
40024	9.030	-36	69	109	16	8	-77	79	0.0710	7.45	-77.046	0.4	0.8	1116.03	0.0762	29.80
40025	9.040	-36	69	108	22	9	-73	77	0.0688	6.98	-72.301	0.4	0.8	1116.03	0.0762	29.81
40026	9.050	-35	69	108	22	8	-71	75	0.0674	6.71	-71.826	0.4	0.8	1116.04	0.0762	29.81
40027	9.060	-35	69	107	17	7	-72	74	0.0666	6.55	-75.898	0.4	0.8	1116.04	0.0762	29.81
40028	9.070	-35	69	106	7	4	-75	75	0.0673	6.70	-83.625	0.4	0.8	1116.04	0.0762	29.81
40029	9.080	-35	69	106	3	4	-75	76	0.0677	6.77	-86.325	0.3	0.7	1116.04	0.0762	29.81
40030	9.090	-35	69	105	0	4	-77	77	0.0691	7.06	-87.061	0.3	0.7	1116.05	0.0762	29.81
40031	9.100	-35	69	104	-2	5	-80	80	0.0717	7.59	-86.155	0.3	0.7	1116.05	0.0762	29.81
40032	9.110	-35	69	103	-3	7	-83	83	0.0745	8.19	-84.731	0.3	0.7	1116.05	0.0762	29.81
40033	9.120	-35	69	102	-5	8	-88	88	0.0791	9.25	-83.885	0.3	0.7	1116.06	0.0762	29.81
40034	9.130	-35	69	101	-7	7	-91	91	0.0817	9.87	-83.878	0.3	0.7	1116.06	0.0762	29.81
40035	9.140	-35	69	100	-8	4	-91	91	0.0819	9.90	-84.543	0.3	0.7	1116.06	0.0763	29.81
40036	9.150	-35	69	100	-7	-1	-89	89	0.0802	9.50	-85.465	0.3	0.7	1116.07	0.0763	29.82
40037	9.160	-35	69	99	-7	-4	-83	83	0.0746	8.23	-84.669	0.3	0.7	1116.07	0.0763	29.82
40038	9.170	-35	69	98	-7	-4	-80	80	0.0720	7.65	-84.268	0.3	0.7	1116.07	0.0763	29.82
40039	9.180	-36	69	97	-7	-2	-78	78	0.0700	7.24	-84.987	0.3	0.7	1116.08	0.0763	29.82
40040	9.190	-36	69	96	-6	3	-76	76	0.0685	6.94	-85.108	0.3	0.7	1116.08	0.0763	29.82
40041	9.200	-36	69	96	-4	6	-77	77	0.0693	7.10	-84.729	0.3	0.7	1116.08	0.0763	29.82
40042	9.210	-36	69	95	-2	8	-77	77	0.0690	7.04	-83.902	0.3	0.7	1116.09	0.0763	29.82
40043	9.220	-36	69	94	-1	9	-78	78	0.0701	7.25	-83.061	0.3	0.7	1116.09	0.0763	29.82
40044	9.230	-36	70	93	-0	10	-80	81	0.0723	7.74	-82.684	0.3	0.7	1116.09	0.0763	29.82
40045	9.240	-36	70	92	-1	13	-83	84	0.0753	8.38	-81.284	0.3	0.7	1116.09	0.0763	29.82
40046	9.250	-36	70	92	-3	13	-88	89	0.0797	9.39	-81.076	0.3	0.6	1116.10	0.0763	29.82
40047	9.260	-36	70	91	-4	12	-90	91	0.0816	9.85	-81.792	0.3	0.6	1116.10	0.0763	29.82
40048	9.270	-36	70	90	-4	10	-90	91	0.0816	9.83	-83.406	0.3	0.6	1116.11	0.0763	29.83
40049	9.280	-36	70	89	-4	4	-89	89	0.0797	9.39	-86.633	0.3	0.6	1116.11	0.0763	29.83
40050	9.290	-36	70	88	-2	1	-86	86	0.0770	8.77	-88.209	0.3	0.6	1116.11	0.0763	29.83
40051	9.300	-36	70	87	-0	2	-84	84	0.0750	8.31	-88.908	0.3	0.6	1116.12	0.0763	29.83
40052	9.310	-36	70	86	-0	4	-82	82	0.0735	7.99	-87.551	0.3	0.6	1116.12	0.0763	29.83
40053	9.320	-36	70	86	-1	8	-81	81	0.0727	7.82	-84.225	0.3	0.6	1116.12	0.0763	29.83
40054	9.330	-36	70	85	-4	9	-81	81	0.0730	7.88	-82.711	0.3	0.6	1116.12	0.0763	29.83
40055	9.340	-36	71	84	-11	9	-82	84	0.0748	8.28	-80.542	0.3	0.6	1116.13	0.0763	29.83
40056	9.350	-36	71	83	-13	7	-83	84	0.0757	8.47	-79.731	0.3	0.6	1116.13	0.0763	29.83
40057	9.360	-36	71	82	-13	5	-84	85	0.0762	8.58	-80.767	0.3	0.6	1116.13	0.0763	29.83
40058	9.370	-36	71	81	-10	4	-84	84	0.0756	8.46	-82.690	0.3	0.6	1116.14	0.0763	29.83
40059	9.380	-36	71	81	-5	5	-83	83	0.0745	8.21	-85.349	0.3	0.6	1116.14	0.0763	29.84
40060	9.390	-36	71	80	-1	6	-82	82	0.0736	8.01	-85.747	0.3	0.6	1116.14	0.0763	29.84
40061	9.400	-36	71	79	2	8	-81	82	0.0731	7.89	-84.364	0.3	0.6	1116.15	0.0763	29.84
40062	9.410	-36	71	78	3	9	-81	81	0.0730	7.88	-83.170	0.3	0.6	1116.15	0.0763	29.84
40063	9.420	-36	71	77	2	10	-81	82	0.0733	7.95	-82.938	0.3	0.5	1116.15	0.0763	29.84
40064	9.430	-36	71	77	1	10	-82	82	0.0736	8.01	-83.281	0.3	0.5	1116.16	0.0763	29.84
40065	9.440	-36	71	76	1	9	-82	82	0.0739	8.07	-83.994	0.2	0.5	1116.16	0.0763	29.84
40066	9.450	-36	71	75	0	6	-83	83	0.0747	8.25	-85.871	0.2	0.5	1116.16	0.0763	29.84
40067	9.460	-36	71	74	-2	5	-84	85	0.0758	8.49	-86.543	0.2	0.5	1116.17	0.0763	29.84
40068	9.470	-36	71	73	-5	4	-86	86	0.0771	8.80	-85.606	0.2	0.5	1116.17	0.0763	29.84
40069	9.480	-36	72	72	-9	4	-88	88	0.0792	9.29	-83.337	0.2	0.5	1116.17	0.0763	29.84
40070	9.490	-36	72	71	-11	6	-88	89	0.0798	9.42	-81.658	0.2	0.5	1116.18	0.0763	29.85
40071	9.500	-37	72	71	-11	7	-87	88	0.0789	9.21	-81.447	0.2	0.5	1116.18	0.0763	29.85
40072	9.510	-37	72	70	-8	8	-85	85	0.0765	8.66	-82.245	0.2	0.5	1116.18	0.0763	29.85
40073	9.520	-37	72	69	-2	9	-80	80	0.0717	7.60	-83.540	0.2	0.5	1116.19	0.0763	29.85
40074	9.530	-37	72	68	0	9	-77	78	0.0697	7.20	-83.708	0.2	0.5	1116.19	0.0763	29.85
40075	9.540	-37	72	67	1	8	-77	77	0.0693	7.11	-83.707	0.2	0.5	1116.19	0.0763	29.85
40076	9.550	-37	72	67	-1	8	-78	79	0.0705	7.36	-84.059	0.2	0.5	1116.19	0.0763	29.85
40077	9.560	-37	72	66	-5	7	-81	82	0.0732	7.92	-83.760	0.2	0.5	1116.20	0.0763	29.85
40078	9.570	-37	72	65	-8	6	-84	84	0.0755	8.43	-82.942	0.2	0.5	1116.20	0.0763	29.85
40079	9.580	-37	72	64	-10	5	-85	86	0.0767	8.70	-82.765	0.2	0.5	1116.20	0.0763	29.85
40080	9.590	-37	72	63	-10	4	-85	85	0.0765	8.66	-82.764	0.2	0.4	1116.21	0.0763	29.85
40081	9.600	-37	72	62	-9	5	-83	84	0.0752	8.36	-83.005	0.2	0.4	1116.21	0.0763	29.85
40082	9.610	-37	72	62	-6	7	-80	80	0.0720	7.68	-82.929	0.2	0.4	1116.21	0.0763	29.86
40083	9.620	-37	73	61	-6	12	-78	80	0.0713	7.53	-80.207	0.2	0.4	1116.22	0.0763	29.86
40084	9.630	-37	73	60	-6	15	-79	80	0.0717	7.61	-78.696	0.2	0.4	1116.22	0.0763	29.86
40085	9.640	-37	73	59	-6	15	-80	82	0.0730	7.90	-78.363	0.2	0.4	1116.22	0.0763	29.86
40086	9.650	-37	73	58	-6	14	-82	84	0.0751	8.34	-79.250	0.2	0.4	1116.23	0.0763	29.86
40087	9.660	-38	73	58	-6	12	-84	85	0.0765	8.66	-81.107	0.2	0.4	1116.23	0.0763	29.86
40088	9.670	-38	73	57	-5	10	-86	86	0.0774	8.87	-82.134	0.2	0.4	1116.23	0.0763	29.86
40089	9.680	-38	73	56	-5	9	-86	87	0.0776	8.90	-82.914	0.2	0.4	1116.24	0.0764	29.86
40090	9.690	-38	73	55	-6	8	-85	86	0.0769	8.76	-83.444	0.2	0.4	1116.24	0.0764	29.86
40091	9.700	-38	74	54	-5	7	-84	84	0.0755	8.43	-84.013	0.2	0.4	1116.24	0.0764	29.86
40092	9.710	-38	74	53	-5	6	-83	84	0.0748	8.29	-84.741	0.2	0.4	1116.25	0.0764	29.86
40093	9.720	-38	74	53	-6	5	-83	83	0.0748	8.28	-84.722	0.2	0.4	1116.25	0.0764	29.87
40094	9.730	-38	74	52	-8	4	-84	84	0.0754	8.41	-83.637	0.2	0.4	1116.25	0.0764	29.87
40095	9.740	-38	74	51	-11	5	-85	85	0.0765	8.67	-81.725	0.2	0.4	1116.26	0.0764	29.87
40096	9.750	-38	74	50	-16	5	-86	87	0.0780	9.01	-79.039	0.2	0.4	1116.26	0.0764	29.87
40097	9.760	-38	74	49	-17	6	-86	88	0.0787	9.18	-77.978	0.2	0.3	1116.26	0.0764	29.87
40098	9.770	-39	74	48	-16	7	-86	88	0.0786	9.15	-78.381	0.2	0.3	1116.26	0.0764	29.87
40099	9.780	-39	74	47	-12	11	-86	87	0.0780	9.02	-79.505	0.2	0.3	1116.27	0.0764	29.87
40100	9.790	-39	74	47	-3	15	-85	86	0.0773	8.85	-79.658	0.2	0.3	1116.27	0.0764	29.87
40101	9.800	-39	74	46	0	20	-85	88	0.0784	9.11	-76.786	0.2	0.3	1116.27	0.0764	29.87
40102	9.810	-39	75	45	1	22	-85	88	0.0789	9.21	-75.473	0.1	0.3	1116.28	0.0764	29.87
40103	9.820	-39	75	44	-1	21	-85	87	0.0783	9.07	-76.089	0.1	0.3	1116.28	0.0764	29.87
40104	9.830	-39	75	43	-5	17	-84	86	0.0769	8.76	-78.053	0.1	0.3	1116.28	0.0764	29.88
40105	9.840	-39	75	42	-7	11	-82	83	0.0744	8.19	-81.238	0.1	0.3	1116.29	0.0764	29.88
40106	9.850	-39	75	41	-8	8	-81	82	0.0735	8.00	-82.003	0.1	0.3	1116.29	0.0764	29.88
40107	9.860	-39	75	41	-9	7	-81	82	0.0733	7.95	-81.905	0.1	0.3	1116.29	0.0764	29.88
40108	9.870	-39	75	40	-10	7	-81	82	0.0737	8.04	-81.337	0.1	0.3	1116.30	0.0764	29.88
40109	9.880	-39	75	39	-12	8	-81	82	0.0733	7.96	-79.705	0.1	0.3	1116.30	0.0764	29.88
40110	9.890	-39	76	38	-13	8	-81	82	0.0735	8.00	-79.058	0.1	0.3	1116.30	0.0764	29.88
40111	9.900	-39	76	37	-13	9	-82	84	0.0750	8.33	-79.355	0.1	0.3	1116.31	0.0764	29.88
40112	9.910	-40	76	37	-10	11	-86	87	0.0779	9.00	-80.186	0.1	0.3	1116.31	0.0764	29.88
40113	9.920	-40	76	36	-6	14	-91	92	0.0823	10.03	-80.559	0.1	0.3	1116.31	0.0764	29.88
40114	9.930	-40	76	35	-3	16	-94	95	0.0855	10.83	-80.150	0.1	0.2	1116.32	0.0764	29.88
40115	9.940	-40	76	34	-1	18	-97	99	0.0888	11.69	-79.476	0.1	0.2	1116.32	0.0764	29.89
40116	9.950	-40	76	33	2	20	-101	103	0.0922	12.60	-78.638	0.1	0.2	1116.32	0.0764	29.89
40117	9.960	-40	77	32								0.1	0.2	1116.33	0.0764	29.89

TABLE E-4

DATA SUMMARY TEST DRUM 7 OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.255	0	100	7								0.0	0.0	1116.42	0.0765	29.91
40002	0.265	1	104	7	2	460	-47	462	0.4139	253.95	-5.831	0.0	0.0	1116.42	0.0765	29.91
40003	0.275	1	109	6	2	398	2	398	0.3562	188.16	0.360	0.0	0.0	1116.43	0.0765	29.91
40004	0.285	1	112	7	2	380	-9	380	0.3407	172.10	-1.386	0.0	0.0	1116.42	0.0765	29.91
40005	0.295	1	115	7	2	361	21	362	0.3243	155.89	3.275	0.0	0.0	1116.42	0.0765	29.91
40006	0.305	1	119	6	2	381	23	382	0.3420	173.43	3.500	0.0	0.0	1116.43	0.0765	29.92
40007	0.315	1	123	7	2	391	38	393	0.3518	183.55	5.478	0.0	0.1	1116.42	0.0765	29.91
40008	0.325	1	127	8	2	395	15	395	0.3541	185.90	2.148	0.0	0.1	1116.42	0.0765	29.91
40009	0.335	1	131	8								0.0	0.1	1116.42	0.0765	29.91

TABLE E-4 (Cont.)

DATA SUMMARY TEST DRUM 10 OPTICL DATA RUN NO 1 UNSMOOTHED TRAJECTORY

PLANE DATA FRAME NO. 00000- 39999 UNIT DATA FRAME NO. 40000-79999

FR	TIME	X	Y	ALT.	VAX	VAY	VZ	VA	M	Q	T.A.	WX	WY	S.S.	RHO	PA
40001	0.380	-51	-7	18								0.1	0.1	1116.38	0.0764	29.90
40002	0.390	-52	-7	19	-100	-14	49	113	0.1009	15.10	25.797	0.1	0.1	1116.38	0.0764	29.90
40003	0.400	-53	-7	19	-90	-12	38	98	0.0882	11.53	22.704	0.1	0.1	1116.38	0.0764	29.90
40004	0.410	-54	-7	19	-82	-11	45	94	0.0845	10.58	28.448	0.1	0.1	1116.38	0.0764	29.90
40005	0.420	-55	-8	20	-82	-11	52	98	0.0875	11.36	31.841	0.1	0.1	1116.37	0.0764	29.90
40006	0.430	-55	-8	21	-86	-12	56	103	0.0922	12.59	32.865	0.1	0.1	1116.37	0.0764	29.90
40007	0.440	-56	-8	21	-85	-12	51	100	0.0894	11.85	30.885	0.1	0.1	1116.37	0.0764	29.90
40008	0.450	-57	-8	22	-84	-12	47	96	0.0863	11.03	28.893	0.1	0.2	1116.37	0.0764	29.90
40009	0.460	-58	-8	22	-81	-11	53	98	0.0877	11.39	33.001	0.1	0.2	1116.37	0.0764	29.90
40010	0.470	-59	-8	23	-89	-12	51	103	0.0925	12.69	29.579	0.1	0.2	1116.36	0.0764	29.90
40011	0.480	-60	-8	23	-109	-15	33	115	0.1029	15.70	16.566	0.1	0.2	1116.36	0.0764	29.90
40012	0.490	-61	-8	24	-116	-16	25	120	0.1075	17.14	12.174	0.1	0.2	1116.36	0.0764	29.90
40013	0.500	-62	-9	23	-104	-14	40	112	0.1002	14.89	20.891	0.1	0.2	1116.36	0.0764	29.90
40014	0.510	-63	-9	24	-86	-12	54	102	0.0916	12.45	31.906	0.1	0.2	1116.36	0.0764	29.90
40015	0.520	-64	-9	25	-71	-10	60	93	0.0837	10.38	40.190	0.1	0.2	1116.35	0.0764	29.89
40016	0.530	-65	-9	25	-69	-10	43	82	0.0730	7.90	31.870	0.1	0.2	1116.35	0.0764	29.89
40017	0.540	-65	-9	26	-75	-10	29	80	0.0721	7.70	20.769	0.1	0.2	1116.35	0.0764	29.89
40018	0.550	-66	-9	26	-81	-11	44	93	0.0832	10.26	27.919	0.1	0.2	1116.35	0.0764	29.89
40019	0.560	-67	-9	26	-91	-13	56	108	0.0968	13.88	31.243	0.1	0.2	1116.35	0.0764	29.89
40020	0.570	-68	-9	27	-100	-14	58	117	0.1044	16.15	30.082	0.1	0.2	1116.35	0.0764	29.89
40021	0.580	-69	-9	28	-98	-14	51	112	0.1001	14.85	27.323	0.1	0.2	1116.34	0.0764	29.89
40022	0.590	-70	-10	28	-91	-13	42	100	0.0900	12.00	24.499	0.1	0.2	1116.34	0.0764	29.89
40023	0.600	-71	-10	28	-80	-11	36	89	0.0794	9.34	23.885	0.1	0.2	1116.34	0.0764	29.89
40024	0.610	-71	-10	29	-77	-11	37	86	0.0769	8.76	25.437	0.1	0.2	1116.34	0.0764	29.89
40025	0.620	-72	-10	29	-92	-13	49	105	0.0941	13.12	27.564	0.1	0.2	1116.34	0.0764	29.89
40026	0.630	-73	-10	30	-108	-15	58	124	0.1106	18.14	28.172	0.1	0.2	1116.34	0.0764	29.89
40027	0.640	-75	-10	31	-109	-15	57	124	0.1112	18.32	27.153	0.1	0.2	1116.33	0.0764	29.89
40028	0.650	-76	-10	31	-93	-13	40	102	0.0917	12.46	23.107	0.1	0.2	1116.33	0.0764	29.89
40029	0.660	-76	-10	31	-69	-10	16	71	0.0638	6.04	13.125	0.1	0.2	1116.33	0.0764	29.89
40030	0.670	-77	-11	31	-65	-9	12	67	0.0598	5.30	10.652	0.1	0.2	1116.33	0.0764	29.89
40031	0.680	-77	-11	31	-78	-11	26	83	0.0739	8.10	18.352	0.1	0.2	1116.33	0.0764	29.89
40032	0.690	-78	-11	32	-83	-12	38	92	0.0822	10.02	24.447	0.1	0.2	1116.33	0.0764	29.89
40033	0.700	-79	-11	32	-87	-12	48	100	0.0896	11.89	28.654	0.1	0.2	1116.33	0.0764	29.89
40034	0.710	-80	-11	33	-93	-13	53	108	0.0969	13.90	29.274	0.1	0.2	1116.33	0.0764	29.89
40035	0.720	-81	-11	33	-100	-14	52	114	0.1017	15.33	27.386	0.1	0.2	1116.32	0.0764	29.89
40036	0.730	-82	-11	34	-107	-15	49	118	0.1059	16.60	24.251	0.1	0.2	1116.32	0.0764	29.89
40037	0.740	-83	-11	34	-104	-15	38	112	0.1005	14.95	19.874	0.1	0.2	1116.32	0.0764	29.88
40038	0.750	-84	-12	34	-97	-14	23	101	0.0904	12.10	13.169	0.1	0.2	1116.32	0.0764	29.88
40039	0.760	-85	-12	35	-96	-13	22	100	0.0893	11.82	12.789	0.1	0.2	1116.32	0.0764	29.88
40040	0.770	-86	-12	35	-99	-14	36	106	0.0954	13.47	19.992	0.1	0.2	1116.32	0.0764	29.88
40041	0.780	-87	-12	35	-93	-13	45	104	0.0933	12.89	25.322	0.1	0.2	1116.32	0.0764	29.88
40042	0.790	-88	-12	36	-84	-12	46	97	0.0867	11.12	28.185	0.1	0.3	1116.31	0.0764	29.88
40043	0.800	-89	-12	36	-77	-11	35	85	0.0762	8.60	24.503	0.1	0.3	1116.31	0.0764	29.88
40044	0.810	-89	-12	37	-74	-10	26	80	0.0713	7.53	19.061	0.1	0.3	1116.31	0.0764	29.88
40045	0.820	-90	-12	37	-82	-12	30	89	0.0793	9.32	19.979	0.1	0.3	1116.31	0.0764	29.88
40046	0.830	-91	-13	37	-88	-12	33	95	0.0852	10.76	20.590	0.1	0.3	1116.31	0.0764	29.88
40047	0.840	-92	-13	37	-91	-13	34	98	0.0879	11.43	20.269	0.1	0.3	1116.31	0.0764	29.88
40048	0.850	-93	-13	38	-89	-12	37	97	0.0872	11.27	22.621	0.1	0.3	1116.31	0.0764	29.88
40049	0.860	-94	-13	38	-83	-12	46	96	0.0856	10.85	29.001	0.1	0.3	1116.30	0.0764	29.88
40050	0.870	-95	-13	39	-81	-11	46	94	0.0844	10.55	29.171	0.1	0.3	1116.30	0.0764	29.88
40051	0.880	-95	-13	39	-83	-12	40	93	0.0836	10.35	25.519	0.1	0.3	1116.30	0.0764	29.88
40052	0.890	-96	-13	39	-88	-12	32	94	0.0844	10.55	19.901	0.1	0.3	1116.30	0.0764	29.88
40053	0.900	-97	-13	40	-90	-13	26	95	0.0849	10.67	15.982	0.1	0.3	1116.30	0.0764	29.88
40054	0.910	-98	-13	40	-86	-12	27	91	0.0816	9.86	17.207	0.1	0.3	1116.30	0.0764	29.88
40055	0.920	-99	-14	40	-85	-12	28	90	0.0806	9.63	18.210	0.1	0.3	1116.30	0.0764	29.88
40056	0.930	-100	-14	40	-88	-12	36	95	0.0855	10.82	22.157	0.1	0.3	1116.29	0.0764	29.88
40057	0.940	-101	-14	41	-91	-13	40	100	0.0899	11.07	23.451	0.1	0.3	1116.29	0.0764	29.88
40058	0.950	-102	-14	42	-96	-14	44	107	0.0956	13.55	24.504	0.1	0.3	1116.29	0.0764	29.88
40059	0.960	-103	-14	42								0.1	0.3	1116.29	0.0764	29.88

APPENDIX F

GAMMA COUNTING DATA

Run 1 Screen Size 26.9 mm, Sample Weight 5.5360 grams

(20 min. live time, 0-2 Mev. F.s, 0.71 gm/cm^2 absorber on face of crystal, sample on absorber)

001 00001	002 00000	003 00004	004 00011	005 00001	006 00132	007 18319	008 28703	009 67925	010 48410
011 68361	012 51751	013 17968	014 10344	015 07364	016 06639	017 06367	018 06166	019 06560	020 07669
021 07759	022 06265	023 04146	024 03216	025 02717	026 02529	027 02364	028 02246	029 02039	030 01814
031 01591	032 01562	033 01413	034 01356	035 01243	036 01184	037 01144	038 01034	039 00957	040 00935
041 00848	042 00865	043 00847	044 00826	045 00717	046 00721	047 00643	048 00670	049 00662	050 00651
051 00611	052 00571	053 00574	054 00561	055 00524	056 00485	057 00514	058 00476	059 00433	060 00448
061 00396	062 00441	063 00394	064 00355	065 00356	066 00354	067 00296	068 00338	069 00353	070 00346
071 00332	072 00388	073 00424	074 00491	075 00528	076 00601	077 00651	078 00633	079 00600	080 00603
081 00451	082 00347	083 00291	084 00234	085 00193	086 00177	087 00195	088 00198	089 00207	090 00194
091 00211	092 00214	093 00202	094 00231	095 00263	096 00327	097 00411	098 00489	099 00530	100 00619
101 00589	102 00642	103 00534	104 00480	105 00339	106 00285	107 00173	108 00120	109 00081	110 00093
111 00075	112 00063	113 00055	114 00046	115 00052	116 00066	117 00059	118 00052	119 00049	120 00058
121 00058	122 00060	123 00045	124 00045	125 00043	126 00035	127 00047	128 00042	129 00045	130 00051
131 00042	132 00028	133 00026	134 00039	135 00035	136 00045	137 00045	138 00040	139 00041	140 00036
141 00048	142 00041	143 00036	144 00034	145 00053	146 00036	147 00046	148 00026	149 00031	150 00026
151 00032	152 00032	153 00029	154 00042	155 00026	156 00032	157 00028	158 00013	159 00024	160 00021
161 00013	162 00021	163 00016	164 00019	165 00015	166 00021	167 00021	168 00012	169 00024	170 00021
171 00014	172 00028	173 00015	174 00021	175 00023	176 00021	177 00016	178 00016	179 00019	180 00024
181 00023	182 00018	183 00019	184 00020	185 00021	186 00015	187 00013	188 00016	189 00009	190 00010
191 00016	192 00008	193 00010	194 00007	195 00005	196 00007	197 00003	198 00005	199 00009	000 00001

Run 2 Screen Size 19.0 mm, Sample Weight 4.7604 grams
(20 min. live time)

001 00000	002 00000	003 00001	004 00003	005 00001	006 00097	007 15863	008 24674	009 58860	010 41051
011 59436	012 43683	013 14935	014 08813	015 06098	016 05619	017 05473	018 05310	019 05767	020 06466
021 06634	022 05271	023 03632	024 02732	025 02391	026 02183	027 01990	028 01876	029 01780	030 01586
031 01403	032 01357	033 01152	034 01191	035 01030	036 01009	037 00919	038 00872	039 00847	040 00812
041 00787	042 00751	043 00674	044 00671	045 00635	046 00607	047 00602	048 00590	049 00572	050 00548
051 00521	052 00472	053 00498	054 00458	055 00435	056 00429	057 00390	058 00428	059 00410	060 00358
061 00339	062 00349	063 00295	064 00288	065 00286	066 00298	067 00293	068 00316	069 00326	070 00314
071 00312	072 00335	073 00410	074 00417	075 00455	076 00531	077 00546	078 00597	079 00576	080 00489
081 00377	082 00321	083 00242	084 00212	085 00194	086 00152	087 00175	088 00157	089 00157	090 00161
091 00170	092 00163	093 00195	094 00195	095 00233	096 00270	097 00342	098 00398	099 00505	100 00525
101 00570	102 00563	103 00478	104 00372	105 00270	106 00173	107 00130	108 00100	109 00086	110 00065
111 00065	112 00058	113 00050	114 00047	115 00035	116 00049	117 00053	118 00055	119 00046	120 00041
121 00042	122 00047	123 00039	124 00042	125 00032	126 00035	127 00038	128 00036	129 00030	130 00028
131 00026	132 00028	133 00026	134 00034	135 00040	136 00028	137 00031	138 00031	139 00037	140 00043
141 00042	142 00035	143 00038	144 00035	145 00030	146 00035	147 00034	148 00027	149 00027	150 00027
151 00024	152 00023	153 00026	154 00030	155 00024	156 00032	157 00017	158 00014	159 00024	160 00017
161 00018	162 00023	163 00012	164 00016	165 00018	166 00022	167 00015	168 00018	169 00019	170 00019
171 00020	172 00025	173 00022	174 00022	175 00027	176 00014	177 00018	178 00014	179 00020	180 00021
181 00020	182 00026	183 00016	184 00020	185 00018	186 00014	187 00012	188 00014	189 00012	190 00006
191 00009	192 00012	193 00009	194 00006	195 00010	196 00002	197 00008	198 00006	199 00004	000 00000

Run 3 Screen Size 13.5 mm, Sample Size 6.9650 grams
(20 min. live time)

001 00004	002 00000	003 00002	004 00001	005 00003	006 00159	007 20562	008 32814	009 78431	010 56206
011 80468	012 60618	013 21312	014 11932	015 08491	016 07700	017 07169	018 07157	019 07793	020 08846
021 08988	022 07071	023 04808	024 03679	025 03162	026 02904	027 02784	028 02656	029 02446	030 02148
031 01987	032 01859	033 01595	034 01518	035 01466	036 01332	037 01255	038 01168	039 01152	040 01041
041 01004	042 00987	043 00924	044 00887	045 00854	046 00809	047 00802	048 00769	049 00703	050 00701
051 00715	052 00691	053 00633	054 00639	055 00598	056 00553	057 00567	058 00608	059 00517	060 00470
061 00476	062 00441	063 00454	064 00400	065 00352	066 00394	067 00390	068 00387	069 00388	070 00399
071 00465	072 00461	073 00567	074 00590	075 00641	076 00728	077 00713	078 00777	079 00730	080 00631
081 00501	082 00430	083 00320	084 00282	085 00217	086 00231	087 00198	088 00208	089 00221	090 00230
091 00214	092 00232	093 00217	094 00334	095 00336	096 00359	097 00504	098 00612	099 00608	100 00758
101 00789	102 00777	103 00634	104 00549	105 00400	106 00264	107 00176	108 00120	109 00087	110 00071
111 00072	112 00075	113 00061	114 00056	115 00059	116 00069	117 00056	118 00057	119 00072	120 00055
121 00057	122 00066	123 00042	124 00057	125 00050	126 00058	127 00026	128 00037	129 00039	130 00046
131 00049	132 00034	133 00043	134 00039	135 00041	136 00029	137 00036	138 00052	139 00047	140 00037
141 00045	142 00041	143 00043	144 00027	145 00032	146 00038	147 00042	148 00034	149 00029	150 00033
151 00021	152 00044	153 00038	154 00033	155 00028	156 00024	157 00034	158 00029	159 00020	160 00016
161 00026	162 00021	163 00022	164 00022	165 00025	166 00018	167 00027	168 00019	169 00029	170 00025
171 00024	172 00021	173 00029	174 00030	175 00026	176 00029	177 00020	178 00025	179 00028	180 00023
181 00025	182 00030	183 00025	184 00028	185 00025	186 00021	187 00014	188 00016	189 00006	190 00014
191 00010	192 00015	193 00011	194 00011	195 00007	196 00006	197 00004	198 00008	199 00006	000 00000

Run 4 Screen Size 9.51 mm, Sample Weight 5.3549 grams
(30 min. live time)

001 00000	002 00000	003 00003	004 00005	005 00000	006 00167	007 21502	008 34174	009 80064	010 55352
011 79384	012 58444	013 19988	014 11437	015 08150	016 07550	017 07125	018 07108	019 07569	020 08819
021 08851	022 07089	023 04730	024 03677	025 03224	026 02833	027 02597	028 02623	029 02436	030 02174
031 01837	032 01785	033 01678	034 01588	035 01368	036 01315	037 01243	038 01172	039 01113	040 01057
041 01005	042 01009	043 00943	044 00885	045 00828	046 00842	047 00784	048 00755	049 00758	050 00715
051 00739	052 00674	053 00637	054 00649	055 00584	056 00597	057 00581	058 00557	059 00552	060 00518
061 00470	062 00468	063 00437	064 00426	065 00432	066 00400	067 00386	068 00399	069 00407	070 00418
071 00425	072 00467	073 00485	074 00616	075 00624	076 00670	077 00777	078 00720	079 00730	080 00641
081 00533	082 00405	083 00334	084 00277	085 00225	086 00247	087 00197	088 00204	089 00220	090 00220
091 00237	092 00261	093 00239	094 00257	095 00319	096 00398	097 00429	098 00548	099 00689	100 00723
101 00750	102 00762	103 00610	104 00510	105 00392	106 00254	107 00185	108 00122	109 00089	110 00101
111 00076	112 00069	113 00076	114 00076	115 00067	116 00078	117 00064	118 00055	119 00064	120 00066
121 00068	122 00074	123 00046	124 00058	125 00064	126 00043	127 00056	128 00038	129 00045	130 00038
131 00045	132 00051	133 00056	134 00045	135 00046	136 00051	137 00049	138 00064	139 00061	140 00040
141 00057	142 00055	143 00054	144 00053	145 00044	146 00046	147 00036	148 00048	149 00044	150 00050
151 00027	152 00035	153 00039	154 00038	155 00026	156 00035	157 00043	158 00028	159 00023	160 00029
161 00020	162 00028	163 00023	164 00024	165 00026	166 00025	167 00031	168 00020	169 00029	170 00031
171 00030	172 00032	173 00036	174 00025	175 00027	176 00027	177 00028	178 00032	179 00024	180 00024
181 00024	182 00028	183 00039	184 00029	185 00012	186 00011	187 00017	188 00025	189 00011	190 00011
191 00017	192 00008	193 00011	194 00010	195 00010	196 00009	197 00007	198 00008	199 00012	000 00000

Run 5 Screen Size 6.73 mm, Sample Weight 8.5643 grams
(30 min. live time)

001 00001	002 00001	003 00001	004 00001	005 00002	006 00931	007 22810	008 38239	009 75496	010 54984
011 76740	012 42599	013 15161	014 09524	015 07322	016 07010	017 06433	018 06668	019 07580	020 08435
021 07768	022 05514	023 03920	024 03102	025 02695	026 02554	027 02410	028 02282	029 01996	030 01871
031 01606	032 01535	033 01384	034 01340	035 01239	036 01194	037 01173	038 01049	039 01030	040 00934
041 01002	042 00940	043 00863	044 00728	045 00776	046 00687	047 00746	048 00710	049 00675	050 00665
051 00620	052 00585	053 00591	054 00570	055 00546	056 00523	057 00494	058 00491	059 00470	060 00447
061 00437	062 00412	063 00427	064 00375	065 00379	066 00391	067 00367	068 00395	069 00376	070 00421
071 00362	072 00485	073 00519	074 00652	075 00697	076 00707	077 00674	078 00705	079 00595	080 00494
081 00376	082 00314	083 00275	084 00220	085 00218	086 00190	087 00214	088 00216	089 00187	090 00209
091 00207	092 00248	093 00251	094 00298	095 00374	096 00423	097 00518	098 00627	099 00692	100 00696
101 00634	102 00560	103 00471	104 00319	105 00220	106 00163	107 00112	108 00082	109 00077	110 00058
111 00062	112 00070	113 00064	114 00074	115 00075	116 00049	117 00051	118 00055	119 00052	120 00058
121 00058	122 00065	123 00045	124 00054	125 00052	126 00042	127 00034	128 00049	129 00041	130 00034
131 00048	132 00051	133 00042	134 00054	135 00048	136 00044	137 00039	138 00044	139 00054	140 00036
141 00040	142 00048	143 00041	144 00045	145 00045	146 00030	147 00049	148 00059	149 00055	150 00037
151 00037	152 00031	153 00020	154 00028	155 00031	156 00036	157 00032	158 00033	159 00017	160 00034
161 00026	162 00015	163 00015	164 00033	165 00020	166 00022	167 00030	168 00031	169 00026	170 00024
171 00033	172 00024	173 00025	174 00013	175 00021	176 00021	177 00016	178 00020	179 00017	180 00020
181 00013	182 00022	183 00027	184 00022	185 00011	186 00016	187 00023	188 00012	189 00011	190 00010
191 00009	192 00006	193 00005	194 00011	195 00007	196 00008	197 00004	198 00011	199 00011	000 00001

Run 7 Screen Size 4.76 mm, Sample Weight 8.8076 grams
(30 min. live time)

001 00002	002 00002	003 00001	004 00008	005 00001	006 00376	007 35023	008 58275	009 27134	010 94427
011 34702	012 79186	013 28234	014 17059	015 12853	016 12462	017 11706	018 11755	019 12987	020 14569
021 13476	022 09755	023 06662	024 05485	025 04916	026 04540	027 04353	028 04089	029 03565	030 03271
031 02835	032 02680	033 02576	034 02279	035 02207	036 02095	037 01968	038 01881	039 01775	040 01662
041 01497	042 01541	043 01384	044 01397	045 01330	046 01257	047 01210	048 01171	049 01153	050 01126
051 01050	052 01016	053 00973	054 00967	055 00904	056 00870	057 00838	058 00823	059 00815	060 00742
061 00691	062 00670	063 00636	064 00682	065 00601	066 00629	067 00641	068 00620	069 00641	070 00732
071 00714	072 00805	073 00959	074 01102	075 01164	076 01147	077 01137	078 01131	079 01011	080 00758
081 00611	082 00501	083 00404	084 00366	085 00371	086 00357	087 00335	088 00324	089 00348	090 00343
091 00397	092 00392	093 00495	094 00567	095 00638	096 00843	097 01004	098 01162	099 01148	100 01220
101 01043	102 00889	103 00679	104 00471	105 00363	106 00235	107 00156	108 00137	109 00119	110 00114
111 00108	112 00090	113 00094	114 00098	115 00091	116 00106	117 00102	118 00093	119 00082	120 00093
121 00083	122 00068	123 00083	124 00069	125 00069	126 00055	127 00059	128 00047	129 00048	130 00073
131 00067	132 00057	133 00067	134 00077	135 00060	136 00073	137 00058	138 00059	139 00075	140 00073
141 00066	142 00070	143 00079	144 00054	145 00067	146 00060	147 00062	148 00052	149 00044	150 00047
151 00047	152 00045	153 00041	154 00028	155 00039	156 00034	157 00047	158 00029	159 00037	160 00032
161 00049	162 00030	163 00035	164 00037	165 00028	166 00036	167 00050	168 00039	169 00048	170 00057
171 00041	172 00040	173 00034	174 00029	175 00043	176 00040	177 00036	178 00033	179 00031	180 00037
181 00036	182 00028	183 00028	184 00022	185 00018	186 00025	187 00017	188 00014	189 00007	190 00019
191 00011	192 00008	193 00009	194 00011	195 00011	196 00007	197 00011	198 00011	199 00012	000 00001

Run 6 Screen Size 3.36 mm, Sample Weight 7.8504 grams
(30 min. live time)

001 00001	002 00000	003 00005	004 00005	005 00003	006 00405	007 31563	008 53311	009 15537	010 86083
011 22784	012 72113	013 25895	014 15514	015 11767	016 11190	017 10612	018 10755	019 12138	020 13552
021 12285	022 08933	023 06251	024 05049	025 04567	026 04121	027 04047	028 03748	029 03424	030 03001
031 02724	032 02567	033 02316	034 02159	035 02109	036 01944	037 01768	038 01688	039 01528	040 01477
041 01453	042 01408	043 01437	044 01291	045 01214	046 01165	047 01099	048 01142	049 01078	050 00988
051 00999	052 00986	053 00926	054 00903	055 00852	056 00812	057 00798	058 00787	059 00736	060 00684
061 00681	062 00627	063 00580	064 00573	065 00564	066 00615	067 00611	068 00630	069 00624	070 00641
071 00696	072 00764	073 00833	074 01023	075 01063	076 01136	077 01102	078 01073	079 00878	080 00733
081 00583	082 00454	083 00354	084 00327	085 00340	086 00315	087 00318	088 00346	089 00332	090 00347
091 00366	092 00402	093 00455	094 00549	095 00591	096 00806	097 00901	098 01077	099 01096	100 01071
101 00986	102 00841	103 00622	104 00446	105 00273	106 00200	107 00163	108 00108	109 00111	110 00122
111 00104	112 00087	113 00095	114 00087	115 00089	116 00075	117 00079	118 00074	119 00076	120 00091
121 00078	122 00076	123 00054	124 00070	125 00062	126 00063	127 00051	128 00070	129 00056	130 00056
131 00062	132 00053	133 00046	134 00055	135 00064	136 00062	137 00060	138 00065	139 00064	140 00071
141 00068	142 00067	143 00062	144 00068	145 00054	146 00051	147 00058	148 00039	149 00056	150 00049
151 00047	152 00049	153 00028	154 00038	155 00042	156 00039	157 00035	158 00036	159 00023	160 00026
161 00025	162 00025	163 00034	164 00030	165 00043	166 00041	167 00037	168 00054	169 00039	170 00043
171 00035	172 00032	173 00038	174 00034	175 00039	176 00025	177 00030	178 00036	179 00038	180 00036
181 00032	182 00042	183 00025	184 00028	185 00021	186 00014	187 00023	188 00016	189 00006	190 00018
191 00009	192 00007	193 00006	194 00011	195 00007	196 00008	197 00004	198 00009	199 00008	000 00002

Run 8 Screen Size 2.38 mm, Sample Weight 6.6391 grams
(30 min. live time)

001 00001	002 00001	003 00000	004 00004	005 00000	006 00303	007 29050	008 48076	009 05905	010 76896
011 09904	012 64767	013 23200	014 13848	015 10757	016 09940	017 09280	018 09531	019 10668	020 12051
021 11110	022 07765	023 05468	024 04478	025 03994	026 03666	027 03504	028 03274	029 03016	030 02638
031 02353	032 02214	033 02134	034 01977	035 01780	036 01694	037 01643	038 01522	039 01373	040 01345
041 01312	042 01286	043 01210	044 01161	045 01058	046 01043	047 01063	048 01025	049 00943	050 00949
051 00901	052 00898	053 00857	054 00773	055 00748	056 00710	057 00715	058 00726	059 00631	060 00590
061 00605	062 00554	063 00557	064 00524	065 00491	066 00524	067 00523	068 00537	069 00529	070 00572
071 00618	072 00669	073 00777	074 00873	075 00930	076 00993	077 00962	078 00915	079 00770	080 00616
081 00476	082 00413	083 00354	084 00294	085 00310	086 00296	087 00287	088 00295	089 00278	090 00325
091 00322	092 00347	093 00388	094 00492	095 00565	096 00721	097 00846	098 00944	099 01009	100 00978
101 00854	102 00755	103 00546	104 00379	105 00259	106 00169	107 00105	108 00109	109 00113	110 00094
111 00109	112 00086	113 00075	114 00070	115 00079	116 00065	117 00088	118 00082	119 00095	120 00063
121 00075	122 00062	123 00060	124 00071	125 00066	126 00068	127 00054	128 00056	129 00053	130 00035
131 00057	132 00048	133 00060	134 00050	135 00052	136 00072	137 00065	138 00057	139 00079	140 00067
141 00053	142 00061	143 00051	144 00065	145 00065	146 00047	147 00057	148 00064	149 00052	150 00040
151 00047	152 00043	153 00041	154 00041	155 00035	156 00029	157 00031	158 00029	159 00036	160 00021
161 00033	162 00033	163 00032	164 00037	165 00029	166 00037	167 00033	168 00032	169 00037	170 00035
171 00041	172 00042	173 00035	174 00023	175 00038	176 00036	177 00049	178 00029	179 00035	180 00029
181 00030	182 00031	183 00023	184 00026	185 00018	186 00023	187 00015	188 00015	189 00012	190 00013
191 00013	192 00009	193 00008	194 00013	195 00015	196 00010	197 00003	198 00005	199 00008	000 00007

Run 9 Screen Size 1.41 mm, Sample Weight 7.3596 grams
(30 min. live time)

001 00000	002 00000	003 00002	004 00003	005 00002	006 00275	007 27770	008 46364	009 02384	010 74775
011 06515	012 62478	013 22237	014 13344	015 10339	016 09713	017 09056	018 09319	019 10471	020 11711
021 10776	022 07621	023 05350	024 04327	025 03826	026 03610	027 03419	028 03276	029 02892	030 02616
031 02399	032 02157	033 02089	034 01888	035 01775	036 01632	037 01546	038 01483	039 01394	040 01387
041 01235	042 01217	043 01172	044 01113	045 01152	046 01037	047 01013	048 00974	049 00985	050 00861
051 00889	052 00834	053 00860	054 00796	055 00754	056 00683	057 00656	058 00642	059 00644	060 00610
061 00599	062 00541	063 00549	064 00548	065 00520	066 00456	067 00491	068 00533	069 00547	070 00549
071 00608	072 00666	073 00757	074 00864	075 00965	076 00995	077 00951	078 00913	079 00757	080 00591
081 00438	082 00378	083 00299	084 00286	085 00269	086 00279	087 00270	088 00308	089 00266	090 00321
091 00322	092 00347	093 00381	094 00464	095 00592	096 00722	097 00841	098 00970	099 00991	100 00954
101 00842	102 00643	103 00508	104 00341	105 00228	106 00168	107 00115	108 00085	109 00091	110 00093
111 00080	112 00100	113 00070	114 00085	115 00081	116 00080	117 00072	118 00088	119 00080	120 00072
121 00061	122 00054	123 00068	124 00055	125 00073	126 00049	127 00049	128 00052	129 00055	130 00038
131 00046	132 00060	133 00050	134 00057	135 00058	136 00068	137 00054	138 00071	139 00067	140 00049
141 00054	142 00055	143 00063	144 00040	145 00048	146 00053	147 00049	148 00034	149 00058	150 00038
151 00047	152 00050	153 00046	154 00047	155 00028	156 00031	157 00031	158 00031	159 00036	160 00028
161 00034	162 00028	163 00022	164 00027	165 00039	166 00035	167 00030	168 00032	169 00034	170 00027
171 00029	172 00040	173 00041	174 00035	175 00031	176 00025	177 00036	178 00041	179 00026	180 00029
181 00034	182 00030	183 00032	184 00018	185 00015	186 00020	187 00015	188 00012	189 00011	190 00015
191 00007	192 00014	193 00007	194 00006	195 00010	196 00014	197 00007	198 00010	199 00009	000 00001

Run 11 Screen Size 1.00 mm, Sample Weight 5.1477 grams
(30 min. live time)

001 00002	002 00000	003 00000	004 00003	005 00003	006 01405	007 21793	008 37318	009 69800	010 52005
011 72944	012 38281	013 14174	014 09014	015 06943	016 06756	017 06081	018 06378	019 07095	020 07902
021 07328	022 05111	023 03604	024 02953	025 02606	026 02397	027 02362	028 02160	029 01993	030 01823
031 01561	032 01432	033 01376	034 01330	035 01194	036 01221	037 01089	038 01031	039 00993	040 00938
041 00835	042 00877	043 00803	044 00784	045 00768	046 00749	047 00652	048 00679	049 00668	050 00653
051 00605	052 00597	053 00585	054 00568	055 00522	056 00479	057 00491	058 00477	059 00457	060 00434
061 00404	062 00390	063 00382	064 00399	065 00371	066 00377	067 00336	068 00342	069 00343	070 00382
071 00448	072 00448	073 00510	074 00606	075 00616	076 00658	077 00689	078 00635	079 00526	080 00460
081 00388	082 00314	083 00267	084 00218	085 00209	086 00177	087 00197	088 00205	089 00180	090 00224
091 00225	092 00243	093 00267	094 00282	095 00346	096 00433	097 00532	098 00605	099 00653	100 00736
101 00666	102 00559	103 00463	104 00333	105 00207	106 00148	107 00098	108 00098	109 00076	110 00074
111 00062	112 00064	113 00062	114 00070	115 00072	116 00052	117 00059	118 00057	119 00070	120 00059
121 00057	122 00043	123 00047	124 00045	125 00047	126 00041	127 00050	128 00035	129 00049	130 00038
131 00042	132 00044	133 00038	134 00041	135 00037	136 00047	137 00046	138 00058	139 00034	140 00047
141 00041	142 00051	143 00047	144 00046	145 00041	146 00041	147 00044	148 00051	149 00039	150 00031
151 00036	152 00031	153 00026	154 00035	155 00031	156 00022	157 00024	158 00027	159 00024	160 00025
161 00025	162 00021	163 00021	164 00026	165 00026	166 00026	167 00021	168 00023	169 00023	170 00029
171 00023	172 00027	173 00026	174 00024	175 00021	176 00023	177 00019	178 00024	179 00026	180 00028
181 00020	182 00029	183 00018	184 00019	185 00023	186 00017	187 00021	188 00021	189 00008	190 00016
191 00011	192 00013	193 00008	194 00007	195 00009	196 00016	197 00011	198 00009	199 00007	000 00006

Run 12 Screen Size 0.841 mm, Sample Weight 4.8409 grams
(30 min. live time)

001 00003	002 00001	003 00001	004 00009	005 00001	006 00763	007 19950	008 32846	009 64432	010 47094
011 66192	012 35377	013 12781	014 08303	015 06430	016 05948	017 05649	018 05770	019 06348	020 07168
021 06606	022 04688	023 03266	024 02615	025 02356	026 02267	027 02069	028 02056	029 01814	030 01663
031 01511	032 01287	033 01295	034 01188	035 01041	036 01007	037 01039	038 00964	039 00880	040 00892
041 00736	042 00764	043 00749	044 00697	045 00681	046 00662	047 00659	048 00599	049 00597	050 00580
051 00573	052 00553	053 00510	054 00515	055 00481	056 00463	057 00450	058 00425	059 00396	060 00386
061 00384	062 00393	063 00343	064 00337	065 00336	066 00324	067 00334	068 00316	069 00367	070 00374
071 00364	072 00410	073 00505	074 00500	075 00598	076 00622	077 00588	078 00576	079 00468	080 00360
081 00355	082 00268	083 00220	084 00202	085 00176	086 00179	087 00202	088 00169	089 00201	090 00176
091 00184	092 00209	093 00235	094 00288	095 00344	096 00427	097 00517	098 00584	099 00594	100 00617
101 00557	102 00485	103 00359	104 00264	105 00162	106 00134	107 00087	108 00085	109 00065	110 00064
111 00057	112 00061	113 00065	114 00060	115 00054	116 00050	117 00066	118 00060	119 00069	120 00052
121 00059	122 00061	123 00060	124 00044	125 00053	126 00044	127 00045	128 00056	129 00045	130 00045
131 00033	132 00047	133 00044	134 00051	135 00038	136 00045	137 00051	138 00044	139 00043	140 00047
141 00047	142 00052	143 00048	144 00030	145 00034	146 00037	147 00036	148 00042	149 00034	150 00022
151 00032	152 00031	153 00025	154 00032	155 00027	156 00032	157 00021	158 00029	159 00026	160 00026
161 00023	162 00031	163 00027	164 00022	165 00026	166 00031	167 00025	168 00024	169 00024	170 00026
171 00022	172 00025	173 00025	174 00022	175 00033	176 00018	177 00026	178 00022	179 00023	180 00024
181 00022	182 00016	183 00029	184 00033	185 00017	186 00010	187 00013	188 00017	189 00021	190 00014
191 00007	192 00008	193 00010	194 00014	195 00012	196 00011	197 00003	198 00010	199 00008	000 00001

Run 10 Screen Size 0.595 mm, Sample Weight 3.9131 grams
(30 min. live time)

001 00002	002 00002	003 00005	004 00015	005 00000	006 00163	007 14227	008 23123	009 49717	010 34682
011 49629	012 28256	013 10140	014 06201	015 04775	016 04577	017 04267	018 04307	019 04819	020 05569
021 05048	022 03522	023 02439	024 02034	025 01749	026 01648	027 01527	028 01468	029 01388	030 01201
031 01145	032 01024	033 00957	034 00930	035 00876	036 00790	037 00748	038 00739	039 00720	040 00628
041 00608	042 00596	043 00545	044 00512	045 00510	046 00551	047 00503	048 00486	049 00480	050 00477
051 00492	052 00472	053 00442	054 00382	055 00393	056 00332	057 00348	058 00362	059 00329	060 00334
061 00343	062 00306	063 00275	064 00282	065 00253	066 00250	067 00254	068 00287	069 00267	070 00287
071 00320	072 00314	073 00412	074 00414	075 00455	076 00455	077 00460	078 00445	079 00369	080 00329
081 00252	082 00225	083 00183	084 00146	085 00154	086 00155	087 00159	088 00166	089 00175	090 00145
091 00141	092 00196	093 00188	094 00257	095 00279	096 00326	097 00392	098 00471	099 00491	100 00467
101 00399	102 00329	103 00262	104 00153	105 00130	106 00107	107 00057	108 00074	109 00058	110 00061
111 00052	112 00056	113 00053	114 00043	115 00057	116 00054	117 00060	118 00050	119 00040	120 00038
121 00058	122 00043	123 00050	124 00030	125 00040	126 00034	127 00028	128 00032	129 00032	130 00040
131 00042	132 00039	133 00037	134 00035	135 00043	136 00036	137 00038	138 00036	139 00038	140 00044
141 00034	142 00031	143 00038	144 00032	145 00034	146 00028	147 00033	148 00032	149 00035	150 00027
151 00027	152 00022	153 00024	154 00026	155 00016	156 00017	157 00025	158 00021	159 00018	160 00019
161 00021	162 00021	163 00019	164 00021	165 00020	166 00031	167 00016	168 00022	169 00022	170 00017
171 00019	172 00012	173 00018	174 00019	175 00024	176 00016	177 00021	178 00019	179 00019	180 00017
181 00017	182 00014	183 00015	184 00019	185 00016	186 00014	187 00015	188 00006	189 00012	190 00014
191 00009	192 00013	193 00007	194 00007	195 00012	196 00008	197 00010	198 00008	199 00006	000 00002

Run 14 Screen Size 0.420 mm, Sample Weight 5.5414 grams
(30 min. live time)

001 00000	002 00000	003 00012	004 00007	005 00001	006 00344	007 17590	008 29572	009 60125	010 43383
011 60022	012 31463	013 11465	014 07316	015 05648	016 05585	017 05032	018 05295	019 06084	020 06610
021 05810	022 04134	023 02927	024 02362	025 02095	026 02018	027 01901	028 01761	029 01643	030 01420
031 01283	032 01187	033 01136	034 01052	035 01012	036 00975	037 00886	038 00877	039 00837	040 00747
041 00664	042 00660	043 00701	044 00653	045 00572	046 00620	047 00560	048 00585	049 00580	050 00542
051 00491	052 00481	053 00484	054 00451	055 00438	056 00446	057 00430	058 00402	059 00377	060 00359
061 00355	062 00332	063 00332	064 00322	065 00318	066 00308	067 00265	068 00299	069 00289	070 00326
071 00367	072 00441	073 00447	074 00458	075 00525	076 00552	077 00559	078 00486	079 00448	080 00378
081 00275	082 00220	083 00197	084 00175	085 00161	086 00209	087 00212	088 00190	089 00177	090 00178
091 00192	092 00207	093 00227	094 00288	095 00335	096 00431	097 00516	098 00523	099 00529	100 00543
101 00445	102 00386	103 00303	104 00212	105 00137	106 00113	107 00081	108 00076	109 00083	110 00058
111 00067	112 00066	113 00051	114 00066	115 00049	116 00053	117 00057	118 00062	119 00065	120 00053
121 00044	122 00043	123 00046	124 00044	125 00045	126 00050	127 00044	128 00036	129 00046	130 00035
131 00034	132 00043	133 00033	134 00042	135 00054	136 00050	137 00044	138 00050	139 00059	140 00050
141 00046	142 00028	143 00032	144 00042	145 00041	146 00031	147 00022	148 00036	149 00022	150 00028
151 00028	152 00030	153 00025	154 00023	155 00032	156 00035	157 00016	158 00020	159 00029	160 00017
161 00021	162 00018	163 00027	164 00017	165 00021	166 00024	167 00018	168 00036	169 00028	170 00015
171 00037	172 00018	173 00026	174 00024	175 00012	176 00021	177 00028	178 00030	179 00020	180 00032
181 00023	182 00013	183 00012	184 00013	185 00019	186 00016	187 00012	188 00012	189 00009	190 00006
191 00008	192 00014	193 00006	194 00007	195 00011	196 00008	197 00011	198 00008	199 00009	000 00001

Run 13 Screen Size 0.354 mm, Sample Weight 3.9813 grams
(30 min. live time)

001 00001	002 00000	003 00002	004 00004	005 00002	006 00347	007 12530	008 20137	009 40027	010 28485
011 39490	012 20406	013 07417	014 04844	015 03805	016 03571	017 03348	018 03532	019 03942	020 04330
021 03843	022 02834	023 01972	024 01628	025 01421	026 01393	027 01258	028 01247	029 01128	030 00992
031 00866	032 00869	033 00811	034 00793	035 00752	036 00660	037 00648	038 00611	039 00586	040 00539
041 00554	042 00473	043 00509	044 00436	045 00403	046 00447	047 00384	048 00457	049 00397	050 00398
051 00364	052 00367	053 00380	054 00336	055 00304	056 00277	057 00294	058 00286	059 00257	060 00255
061 00255	062 00212	063 00233	064 00224	065 00209	066 00220	067 00227	068 00228	069 00226	070 00228
071 00242	072 00319	073 00340	074 00368	075 00413	076 00396	077 00377	078 00317	079 00303	080 00272
081 00211	082 00135	083 00166	084 00132	085 00139	086 00147	087 00134	088 00137	089 00117	090 00129
091 00141	092 00155	093 00160	094 00201	095 00208	096 00280	097 00334	098 00364	099 00348	100 00364
101 00306	102 00247	103 00188	104 00174	105 00111	106 00102	107 00059	108 00073	109 00057	110 00048
111 00057	112 00063	113 00041	114 00036	115 00048	116 00048	117 00043	118 00038	119 00034	120 00036
121 00035	122 00039	123 00032	124 00035	125 00044	126 00040	127 00030	128 00035	129 00039	130 00030
131 00026	132 00038	133 00037	134 00038	135 00033	136 00044	137 00037	138 00039	139 00045	140 00038
141 00036	142 00049	143 00032	144 00032	145 00036	146 00013	147 00028	148 00020	149 00023	150 00023
151 00028	152 00021	153 00032	154 00019	155 00020	156 00020	157 00018	158 00017	159 00014	160 00020
161 00018	162 00017	163 00012	164 00014	165 00013	166 00020	167 00017	168 00012	169 00018	170 00016
171 00021	172 00017	173 00016	174 00019	175 00016	176 00020	177 00016	178 00015	179 00023	180 00017
181 00016	182 00012	183 00016	184 00016	185 00011	186 00018	187 00010	188 00013	189 00008	190 00006
191 00006	192 00005	193 00005	194 00008	195 00014	196 00014	197 00006	198 00003	199 00016	000 00002

Run 15 Screen Size 0.210 mm, Sample Weight 4.4119 grams
(30 min. live time)

001 00000	002 00000	003 00013	004 00036	005 00004	006 00328	007 18476	008 30344	009 62888	010 44980
011 63568	012 34721	013 12385	014 08009	015 06135	016 05934	017 05409	018 05694	019 06480	020 07122
021 06293	022 04379	023 03114	024 02658	025 02350	026 02190	027 02085	028 01896	029 01741	030 01676
031 01431	032 01382	033 01196	034 01182	035 01031	036 01039	037 00988	038 00903	039 00884	040 00829
041 00761	042 00742	043 00696	044 00728	045 00708	046 00654	047 00620	048 00590	049 00574	050 00606
051 00558	052 00520	053 00504	054 00529	055 00478	056 00479	057 00422	058 00436	059 00411	060 00401
061 00370	062 00347	063 00341	064 00348	065 00343	066 00341	067 00297	068 00363	069 00322	070 00343
071 00387	072 00420	073 00458	074 00574	075 00585	076 00608	077 00592	078 00503	079 00433	080 00352
081 00278	082 00251	083 00213	084 00196	085 00176	086 00182	087 00173	088 00199	089 00216	090 00198
091 00206	092 00223	093 00243	094 00303	095 00361	096 00434	097 00474	098 00584	099 00613	100 00590
101 00501	102 00415	103 00307	104 00214	105 00128	106 00116	107 00094	108 00066	109 00072	110 00070
111 00054	112 00053	113 00057	114 00057	115 00053	116 00067	117 00052	118 00056	119 00051	120 00047
121 00042	122 00048	123 00045	124 00053	125 00036	126 00050	127 00044	128 00033	129 00042	130 00048
131 00040	132 00043	133 00049	134 00041	135 00045	136 00033	137 00052	138 00051	139 00038	140 00047
141 00046	142 00038	143 00036	144 00039	145 00027	146 00038	147 00030	148 00038	149 00031	150 00033
151 00030	152 00025	153 00021	154 00025	155 00023	156 00022	157 00029	158 00022	159 00022	160 00020
161 00018	162 00030	163 00017	164 00022	165 00020	166 00021	167 00030	168 00023	169 00022	170 00032
171 00027	172 00024	173 00013	174 00015	175 00019	176 00017	177 00024	178 00029	179 00021	180 00024
181 00021	182 00016	183 00016	184 00010	185 00017	186 00016	187 00013	188 00012	189 00007	190 00008
191 00008	192 00005	193 00006	194 00009	195 00007	196 00010	197 00014	198 00008	199 00005	000 00002

Run 16 Screen Size 0.149, Sample Weight 5.6727 grams
(30 min. live time)

001 00000	002 00002	003 00003	004 00003	005 00002	006 00446	007 40730	008 69531	009 47546	010 17580
011 69405	012 04257	013 39960	014 24014	015 17869	016 17182	017 16171	018 16409	019 18109	020 19781
021 18284	022 13572	023 09891	024 08193	025 07329	026 06676	027 06294	028 05980	029 05445	030 04971
031 04505	032 04017	033 03876	034 03615	035 03347	036 03268	037 02973	038 02724	039 02555	040 02450
041 02242	042 02193	043 02020	044 02028	045 01910	046 01855	047 01774	048 01679	049 01629	050 01495
051 01527	052 01461	053 01328	054 01396	055 01290	056 01228	057 01098	058 01076	059 01042	060 01000
061 00981	062 00933	063 00920	064 00867	065 00848	066 00838	067 00876	068 00860	069 00850	070 00920
071 00990	072 01080	073 01246	074 01386	075 01526	076 01525	077 01450	078 01401	079 01083	080 00984
081 00674	082 00543	083 00523	084 00425	085 00472	086 00451	087 00447	088 00441	089 00422	090 00490
091 00505	092 00539	093 00632	094 00824	095 00930	096 01081	097 01288	098 01525	099 01469	100 01499
101 01337	102 01101	103 00780	104 00515	105 00380	106 00237	107 00181	108 00167	109 00151	110 00127
111 00115	112 00125	113 00111	114 00113	115 00098	116 00122	117 00121	118 00101	119 00099	120 00101
121 00082	122 00093	123 00106	124 00090	125 00090	126 00081	127 00054	128 00052	129 00059	130 00069
131 00064	132 00060	133 00078	134 00093	135 00076	136 00065	137 00076	138 00085	139 00087	140 00069
141 00086	142 00074	143 00076	144 00076	145 00068	146 00073	147 00072	148 00062	149 00061	150 00061
151 00061	152 00059	153 00045	154 00063	155 00050	156 00043	157 00042	158 00047	159 00035	160 00030
161 00032	162 00039	163 00048	164 00061	165 00049	166 00045	167 00054	168 00051	169 00047	170 00056
171 00043	172 00043	173 00047	174 00036	175 00064	176 00051	177 00040	178 00050	179 00037	180 00042
181 00037	182 00028	183 00031	184 00024	185 00022	186 00019	187 00019	188 00015	189 00008	190 00012
191 00017	192 00010	193 00013	194 00008	195 00006	196 00008	197 00013	198 00002	199 00007	000 00004

Run 17 Screen Size 0.105 mm, Sample Weight 4.1929 grams
(30 min. live time)

2	002 00000	003 00005	004 00005	005 00003	006 00458	007 39588	008 65946	009 39421	010 04869
011 48971	012 89008	013 33457	014 20602	015 15896	016 14868	017 13982	018 14023	019 15372	020 17151
021 15511	022 11408	023 08145	024 06764	025 05938	026 05692	027 05249	028 04949	029 04428	030 03907
031 03698	032 03432	033 03204	034 03014	035 02708	036 02574	037 02375	038 02219	039 02109	040 02030
041 01897	042 01839	043 01701	044 01614	045 01571	046 01479	047 01405	048 01387	049 01386	050 01313
051 01213	052 01268	053 01164	054 01143	055 01023	056 01019	057 00969	058 00969	059 00838	060 00809
061 00852	062 00790	063 00746	064 00736	065 00749	066 00725	067 00695	068 00735	069 00678	070 00781
071 00856	072 00921	073 01066	074 01129	075 01248	076 01331	077 01219	078 01222	079 00952	080 00771
081 00608	082 00493	083 00425	084 00425	085 00376	086 00381	087 00380	088 00377	089 00379	090 00402
091 00440	092 00423	093 00516	094 00644	095 00820	096 00971	097 01085	098 01220	099 01297	100 01198
101 01102	102 00937	103 00660	104 00490	105 00295	106 00205	107 00163	108 00135	109 00129	110 00120
111 00102	112 00105	113 00107	114 00104	115 00089	116 00114	117 00124	118 00087	119 00096	120 00102
121 00085	122 00100	123 00071	124 00074	125 00066	126 00066	127 00071	128 00062	129 00072	130 00076
131 00068	132 00077	133 00085	134 00063	135 00064	136 00076	137 00054	138 00080	139 00072	140 00086
141 00075	142 00045	143 00076	144 00073	145 00074	146 00043	147 00053	148 00068	149 00063	150 00077
151 00068	152 00054	153 00058	154 00041	155 00048	156 00043	157 00034	158 00033	159 00034	160 00026
161 00026	162 00032	163 00038	164 00038	165 00030	166 00039	167 00039	168 00041	169 00035	170 00049
171 00044	172 00045	173 00036	174 00035	175 00036	176 00039	177 00054	178 00048	179 00032	180 00026
181 00041	182 00035	183 00039	184 00027	185 00019	186 00022	187 00016	188 00015	189 00012	190 00010
191 00008	192 00010	193 00006	194 00010	195 00014	196 00007	197 00011	198 00007	199 00008	000 00002

Run 18 Screen Size 0.074 mm, Sample Weight 3.2328 grams
(30 min. live time)

001 00000	002 00001	003 00023	004 00041	005 00002	006 00180	007 14245	008 21879	009 48029	010 33064
011 47546	012 28428	013 09875	014 06095	015 04499	016 04491	017 04110	018 04075	019 04657	020 05250
021 05061	022 03605	023 02439	024 01929	025 01671	026 01657	027 01562	028 01447	029 01247	030 01122
031 01082	032 00924	033 00890	034 00877	035 00806	036 00751	037 00728	038 00696	039 00674	040 00646
041 00574	042 00572	043 00531	044 00557	045 00477	046 00517	047 00456	048 00477	049 00453	050 00440
051 00454	052 00458	053 00378	054 00405	055 00377	056 00384	057 00344	058 00368	059 00326	060 00316
061 00302	062 00281	063 00281	064 00246	065 00242	066 00262	067 00256	068 00238	069 00232	070 00290
071 00296	072 00327	073 00349	074 00400	075 00388	076 00470	077 00453	078 00382	079 00361	080 00341
081 00227	082 00235	083 00173	084 00160	085 00145	086 00159	087 00135	088 00144	089 00146	090 00169
091 00165	092 00149	093 00175	094 00239	095 00223	096 00269	097 00373	098 00406	099 00433	100 00478
101 00432	102 00340	103 00294	104 00215	105 00162	106 00102	107 00077	108 00073	109 00066	110 00064
111 00054	112 00050	113 00064	114 00053	115 00046	116 00043	117 00052	118 00040	119 00043	120 00044
121 00039	122 00039	123 00048	124 00045	125 00035	126 00041	127 00032	128 00032	129 00024	130 00033
131 00023	132 00044	133 00043	134 00039	135 00038	136 00032	137 00044	138 00043	139 00038	140 00046
141 00037	142 00043	143 00037	144 00036	145 00033	146 00025	147 00029	148 00033	149 00024	150 00027
151 00028	152 00030	153 00029	154 00026	155 00024	156 00020	157 00027	158 00029	159 00017	160 00027
161 00017	162 00028	163 00019	164 00025	165 00020	166 00023	167 00020	168 00028	169 00024	170 00027
171 00017	172 00019	173 00017	174 00016	175 00023	176 00021	177 00017	178 00016	179 00020	180 00016
181 00021	182 00019	183 00027	184 00017	185 00011	186 00011	187 00009	188 00008	189 00015	190 00009
191 00009	192 00012	193 00004	194 00004	195 00008	196 00012	197 00010	198 00005	199 00012	000 00001

Run 19 Screen Size 0.053 mm, Sample Weight 3.0172 grams
(60 min. live time)

001 00000	002 00000	003 00007	004 00013	005 00000	006 00852	007 10043	008 16543	009 27979	010 2015
011 26449	012 11234	013 04377	014 02883	015 02502	016 02453	017 02130	018 02411	019 02728	020 03053
021 02703	022 01903	023 01397	024 01173	025 01123	026 01078	027 00931	028 00915	029 00848	030 00722
031 00691	032 00647	033 00637	034 00618	035 00522	036 00571	037 00494	038 00472	039 00507	040 00445
041 00450	042 00451	043 00452	044 00459	045 00450	046 00413	047 00413	048 00392	049 00371	050 00418
051 00390	052 00405	053 00331	054 00327	055 00332	056 00308	057 00322	058 00292	059 00274	060 00284
061 00274	062 00290	063 00275	064 00253	065 00243	066 00217	067 00222	068 00215	069 00225	070 00271
071 00264	072 00268	073 00284	074 00313	075 00338	076 00324	077 00314	078 00324	079 00245	080 00211
081 00207	082 00185	083 00151	084 00136	085 00152	086 00152	087 00150	088 00139	089 00157	090 00144
091 00143	092 00158	093 00181	094 00182	095 00232	096 00264	097 00283	098 00287	099 00300	100 00288
101 00227	102 00222	103 00175	104 00130	105 00127	106 00081	107 00100	108 00081	109 00077	110 00065
111 00068	112 00076	113 00077	114 00067	115 00069	116 00062	117 00065	118 00069	119 00069	120 00065
121 00069	122 00068	123 00056	124 00047	125 00040	126 00049	127 00050	128 00052	129 00058	130 00036
131 00048	132 00065	133 00052	134 00065	135 00047	136 00062	137 00067	138 00065	139 00046	140 00059
141 00046	142 00070	143 00051	144 00052	145 00050	146 00046	147 00043	148 00026	149 00041	150 00031
151 00048	152 00030	153 00031	154 00035	155 00025	156 00033	157 00033	158 00026	159 00032	160 00033
161 00039	162 00027	163 00033	164 00032	165 00032	166 00034	167 00036	168 00034	169 00039	170 00027
171 00025	172 00031	173 00030	174 00038	175 00015	176 00026	177 00020	178 00034	179 00030	180 00027
181 00028	182 00022	183 00029	184 00011	185 00019	186 00021	187 00025	188 00015	189 00016	190 00019
191 00017	192 00013	193 00011	194 00013	195 00015	196 00013	197 00014	198 00016	199 00012	000 00001

Run 20 Screen Size 0.037 mm, Sample Weight 3.0020 grams
(60 min. live time)

001 00000	002 00000	003 00007	004 00004	005 00002	006 00279	007 05376	008 07440	009 13414	010 08844
011 11635	012 04995	013 02012	014 01471	015 01294	016 01205	017 01205	018 01217	019 01393	020 01524
021 01450	022 01026	023 00810	024 00724	025 00665	026 00616	027 00532	028 00503	029 00529	030 00491
031 00420	032 00399	033 00415	034 00395	035 00392	036 00366	037 00341	038 00316	039 00332	040 00323
041 00333	042 00327	043 00328	044 00261	045 00303	046 00306	047 00290	048 00330	049 00297	050 00337
051 00285	052 00315	053 00291	054 00248	055 00224	056 00253	057 00247	058 00207	059 00203	060 00196
061 00202	062 00218	063 00167	064 00196	065 00185	066 00177	067 00168	068 00183	069 00165	070 00176
071 00164	072 00181	073 00209	074 00184	075 00214	076 00188	077 00188	078 00169	079 00151	080 00133
081 00144	082 00135	083 00129	084 00100	085 00117	086 00116	087 00108	088 00121	089 00130	090 00124
091 00091	092 00115	093 00127	094 00117	095 00155	096 00150	097 00183	098 00160	099 00166	100 00175
101 00158	102 00134	103 00095	104 00100	105 00088	106 00072	107 00071	108 00073	109 00078	110 00060
111 00065	112 00066	113 00050	114 00068	115 00060	116 00063	117 00049	118 00065	119 00059	120 00053
121 00052	122 00047	123 00059	124 00053	125 00055	126 00051	127 00057	128 00052	129 00044	130 00047
131 00055	132 00064	133 00060	134 00056	135 00054	136 00059	137 00054	138 00062	139 00055	140 00057
141 00047	142 00037	143 00041	144 00047	145 00046	146 00040	147 00040	148 00037	149 00034	150 00033
151 00036	152 00028	153 00025	154 00028	155 00026	156 00029	157 00035	158 00029	159 00025	160 00036
161 00029	162 00023	163 00034	164 00020	165 00022	166 00025	167 00027	168 00022	169 00032	170 00023
171 00013	172 00022	173 00011	174 00031	175 00021	176 00017	177 00020	178 00013	179 00022	180 00011
181 00022	182 00012	183 00029	184 00014	185 00016	186 00017	187 00011	188 00011	189 00016	190 00020
191 00023	192 00018	193 00009	194 00018	195 00009	196 00022	197 00020	198 00023	199 00010	000 00002

Run 21 Screen Size < 0.037 mm, Sample Weight 0.5128 gram
(60 min. live time)

001 00000	002 00001	003 00003	004 00000	005 00001	006 00245	007 02145	008 01855	009 02238	010 01485
011 00979	012 00618	013 00531	014 00568	015 00550	016 00522	017 00533	018 00453	019 00532	020 00552
021 00561	022 00529	023 00502	024 00510	025 00432	026 00446	027 00391	028 00395	029 00332	030 00357
031 00337	032 00276	033 00300	034 00298	035 00298	036 00297	037 00277	038 00282	039 00236	040 00256
041 00227	042 00261	043 00248	044 00254	045 00246	046 00263	047 00224	048 00238	049 00245	050 00258
051 00240	052 00251	053 00192	054 00200	055 00200	056 00207	057 00185	058 00214	059 00168	060 00169
061 00176	062 00165	063 00166	064 00143	065 00134	066 00143	067 00123	068 00135	069 00118	070 00121
071 00116	072 00091	073 00124	074 00116	075 00120	076 00135	077 00105	078 00114	079 00118	080 00099
081 00091	082 00118	083 00111	084 00097	085 00104	086 00105	087 00108	088 00099	089 00108	090 00095
091 00100	092 00074	093 00065	094 00087	095 00089	096 00080	097 00073	098 00082	099 00063	100 00081
101 00075	102 00062	103 00064	104 00084	105 00071	106 00067	107 00063	108 00059	109 00068	110 00059
111 00059	112 00055	113 00062	114 00050	115 00058	116 00047	117 00053	118 00054	119 00052	120 00055
121 00051	122 00045	123 00059	124 00050	125 00044	126 00038	127 00046	128 00043	129 00042	130 00052
131 00045	132 00044	133 00059	134 00060	135 00057	136 00047	137 00050	138 00057	139 00056	140 00059
141 00040	142 00058	143 00057	144 00040	145 00040	146 00030	147 00028	148 00032	149 00029	150 00023
151 00040	152 00030	153 00025	154 00023	155 00040	156 00024	157 00032	158 00025	159 00012	160 00032
161 00020	162 00022	163 00017	164 00037	165 00030	166 00019	167 00026	168 00022	169 00021	170 00023
171 00021	172 00023	173 00016	174 00018	175 00022	176 00018	177 00020	178 00018	179 00020	180 00018
181 00022	182 00017	183 00014	184 00028	185 00011	186 00014	187 00016	188 00011	189 00017	190 00011
191 00013	192 00017	193 00019	194 00021	195 00019	196 00018	197 00013	198 00022	199 00016	000 00001

U Standard, 30 min. live time, 0-2 Mev full scale

001 00000	002 00000	003 00001	004 00001	005 00000	006 00347	007 09169	008 15144	009 30121	010 22335
011 31012	012 16276	013 06179	014 03814	015 03100	016 02798	017 02722	018 02822	019 03267	020 03519
021 03120	022 02201	023 01603	024 01417	025 01184	026 01167	027 01133	028 01032	029 00907	030 00828
031 00778	032 00747	033 00672	034 00604	035 00589	036 00592	037 00551	038 00495	039 00510	040 00465
041 00448	042 00424	043 00438	044 00393	045 00364	046 00392	047 00365	048 00362	049 00372	050 00382
051 00354	052 00341	053 00286	054 00256	055 00283	056 00285	057 00236	058 00263	059 00259	060 00216
061 00221	062 00238	063 00182	064 00185	065 00194	066 00184	067 00206	068 00188	069 00187	070 00202
071 00200	072 00228	073 00276	074 00317	075 00314	076 00338	077 00289	078 00265	079 00233	080 00234
081 00178	082 00138	083 00124	084 00133	085 00110	086 00119	087 00111	088 00104	089 00134	090 00112
091 00130	092 00125	093 00166	094 00174	095 00208	096 00239	097 00282	098 00296	099 00300	100 00289
101 00236	102 00224	103 00166	104 00113	105 00073	106 00062	107 00055	108 00055	109 00047	110 00046
111 00042	112 00052	113 00038	114 00033	115 00049	116 00030	117 00038	118 00052	119 00034	120 00037
121 00043	122 00032	123 00023	124 00035	125 00019	126 00022	127 00034	128 00036	129 00036	130 00042
131 00031	132 00030	133 00034	134 00034	135 00033	136 00037	137 00034	138 00029	139 00035	140 00039
141 00037	142 00050	143 00023	144 00030	145 00028	146 00028	147 00019	148 00028	149 00022	150 00022
151 00027	152 00016	153 00015	154 00025	155 00024	156 00018	157 00018	158 00011	159 00014	160 00023
161 00013	162 00015	163 00017	164 00017	165 00014	166 00013	167 00021	168 00017	169 00023	170 00020
171 00019	172 00016	173 00023	174 00016	175 00015	176 00023	177 00014	178 00013	179 00024	180 00010
181 00008	182 00016	183 00004	184 00013	185 00013	186 00011	187 00011	188 00009	189 00011	190 00010
191 00007	192 00011	193 00005	194 00006	195 00014	196 00009	197 00008	198 00012	199 00007	000 00000

Background 60 min. live time, 0 - 2 Mev. full scale (10 kev/ch)

001 00000	002 00000	003 00003	004 00020	005 00000	006 00243	007 02035	008 01726	009 01966	010 01267
011 00743	012 00542	013 00480	014 00502	015 00473	016 00456	017 00468	018 00468	019 00471	020 00522
021 00512	022 00518	023 00471	024 00453	025 00448	026 00394	027 00364	028 00357	029 00335	030 00333
031 00294	032 00305	033 00312	034 00322	035 00295	036 00302	037 00280	038 00250	039 00250	040 00233
041 00254	042 00211	043 00234	044 00261	045 00249	046 00251	047 00231	048 00226	049 00245	050 00251
051 00257	052 00235	053 00199	054 00189	055 00213	056 00185	057 00190	058 00170	059 00170	060 00150
061 00175	062 00147	063 00134	064 00147	065 00133	066 00140	067 00110	068 00108	069 00121	070 00125
071 00134	072 00116	073 00097	074 00109	075 00117	076 00134	077 00103	078 00101	079 00112	080 00147
081 00108	082 00097	083 00109	084 00099	085 00101	086 00089	087 00111	088 00092	089 00104	090 00091
091 00081	092 00078	093 00083	094 00074	095 00074	096 00088	097 00063	098 00063	099 00094	100 00086
101 00066	102 00076	103 00076	104 00077	105 00067	106 00074	107 00059	108 00071	109 00062	110 00055
111 00056	112 00058	113 00051	114 00048	115 00051	116 00046	117 00063	118 00038	119 00049	120 00050
121 00043	122 00042	123 00046	124 00052	125 00044	126 00047	127 00056	128 00043	129 00053	130 00036
131 00052	132 00048	133 00043	134 00049	135 00046	136 00057	137 00047	138 00053	139 00061	140 00048
141 00051	142 00035	143 00047	144 00041	145 00024	146 00022	147 00028	148 00025	149 00027	150 00025
151 00032	152 00025	153 00028	154 00028	155 00027	156 00017	157 00027	158 00026	159 00028	160 00029
161 00031	162 00027	163 00023	164 00035	165 00025	166 00021	167 00022	168 00023	169 00015	170 00021
171 00024	172 00025	173 00019	174 00024	175 00019	176 00014	177 00020	178 00027	179 00014	180 00019
181 00014	182 00020	183 00019	184 00010	185 00023	186 00022	187 00020	188 00014	189 00019	190 00020
191 00012	192 00017	193 00019	194 00012	195 00018	196 00019	197 00017	198 00014	199 00019	000 00000

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